Compressed Air Magazine

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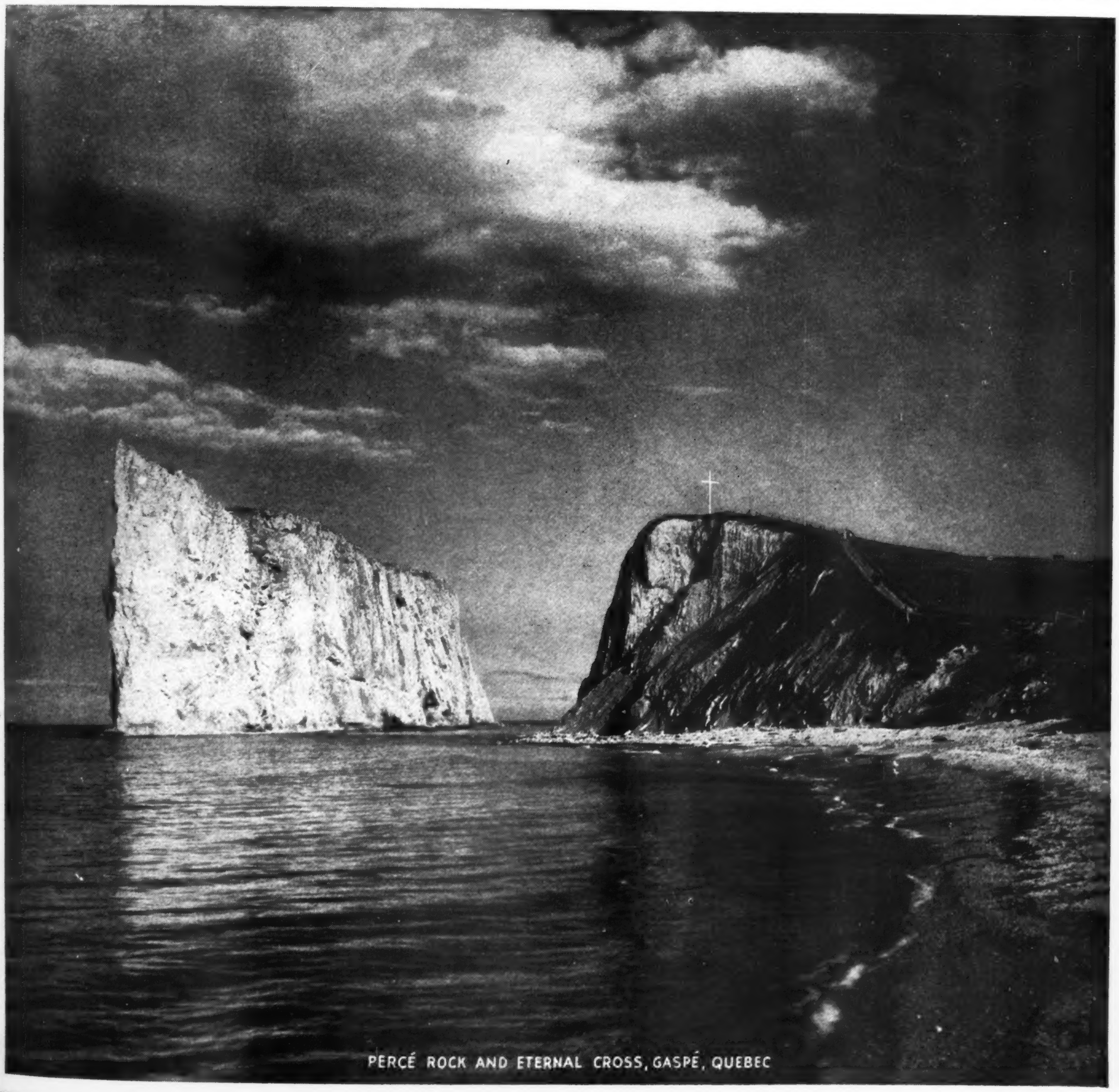

PERCÉ ROCK AND ETERNAL CROSS, GASPÉ, QUEBEC

ON THE COVER

PERCE Rock, or Pierced Rock, to give it its English name, is one of the sights along the St. Lawrence Gulf shore line of the Gaspé Peninsula. Legend has it that it is one of the remnants of a natural rock causeway that at one time spanned the waterway at that point. The cross on the mainland is typical of French-Canadian country.

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IN THIS ISSUE

THE modern automobile torpedo, which may weigh a ton or more, can keep to its course like a high-speed express train and contains in its head 660 pounds of intensely destructive TNT. It is hard to believe that this weapon has gradually developed from a torpedo that could maintain a speed of 6 knots for a few hundred feet, was very erratic in its travel, and carried a charge of 18 pounds of dynamite. The story of that evolution is told in our first article by Robert G. Skerrett, and is a companion piece to his description of modern submarines in our April issue.

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THIS is the time of year when lassitude overcomes many of us and we seek to bolster our mental and physical equipment by leaving our daily work for a brief sojourn in Vacationland. Perhaps those who like the tang of sea air will get the urge to pack up and go when they read what a St. Lawrence Gulf cruise has to offer.

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BUSINESSMEN usually prefer to do their train traveling at night, sleeping as they ride. Tourists, on the other hand, favor trips by day, especially when traversing country of scenic appeal. To serve these sight-seers, the Southern Pacific Railroad runs four finely appointed Daylight Limiteds between San Francisco and Los Angeles daily. So that these trains may maintain an average speed of 50 miles an hour, extensive improvements have been made in the track alignment and surfacing. *Streamliners on the King's Highway* gives some of the particulars.

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AMONG the shorter material, interest attaches especially to the articles on the Roosevelt Tunnel, the recovery of trapped oil in a special way with compressed air, and the symphony concert that was held in a gold mine.

Compressed Air Magazine

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EDITORIAL CONTENTS

ADVERTISING INDEX

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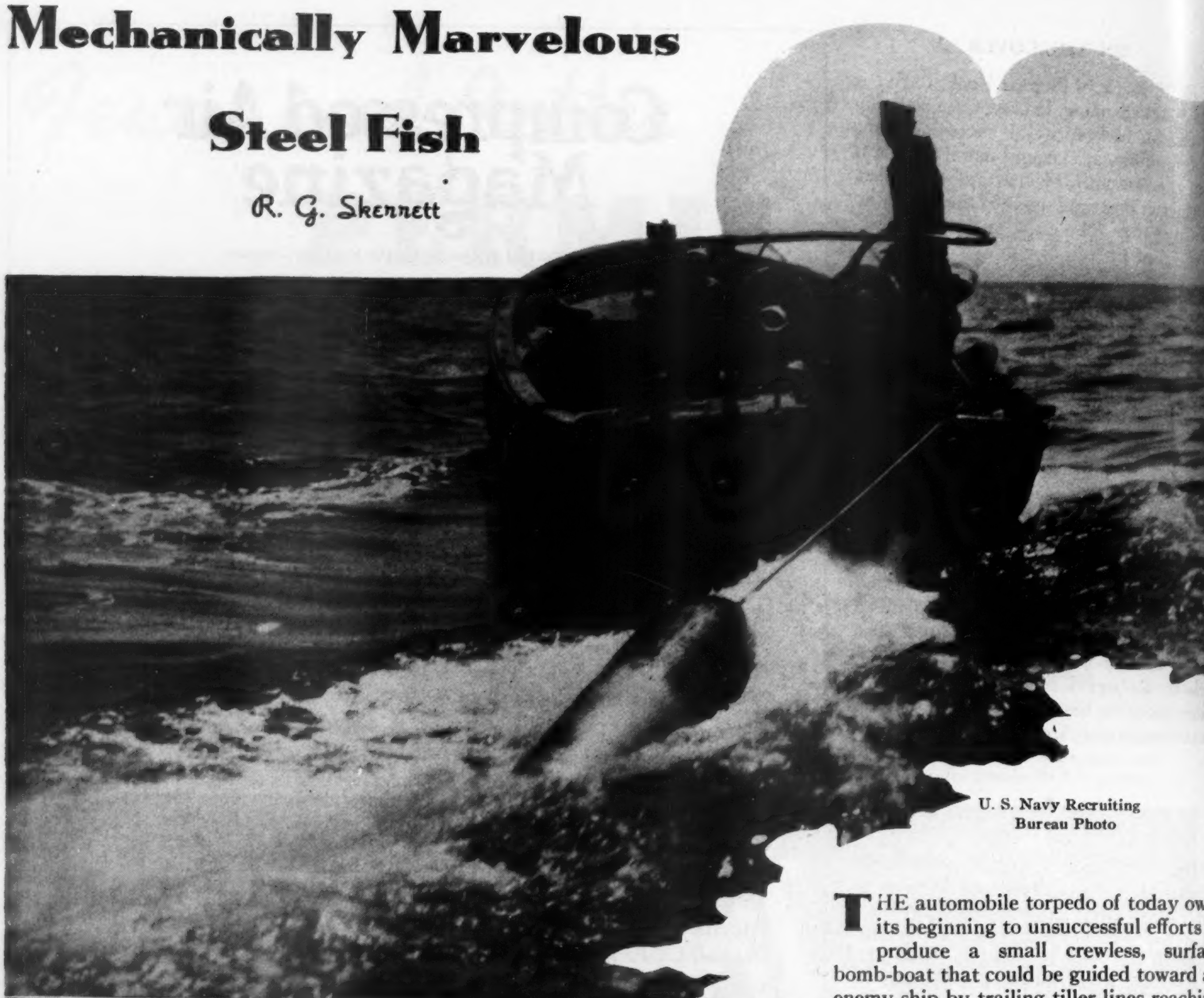
Mechanically Marvelous Steel Fish

R. G. Skennett



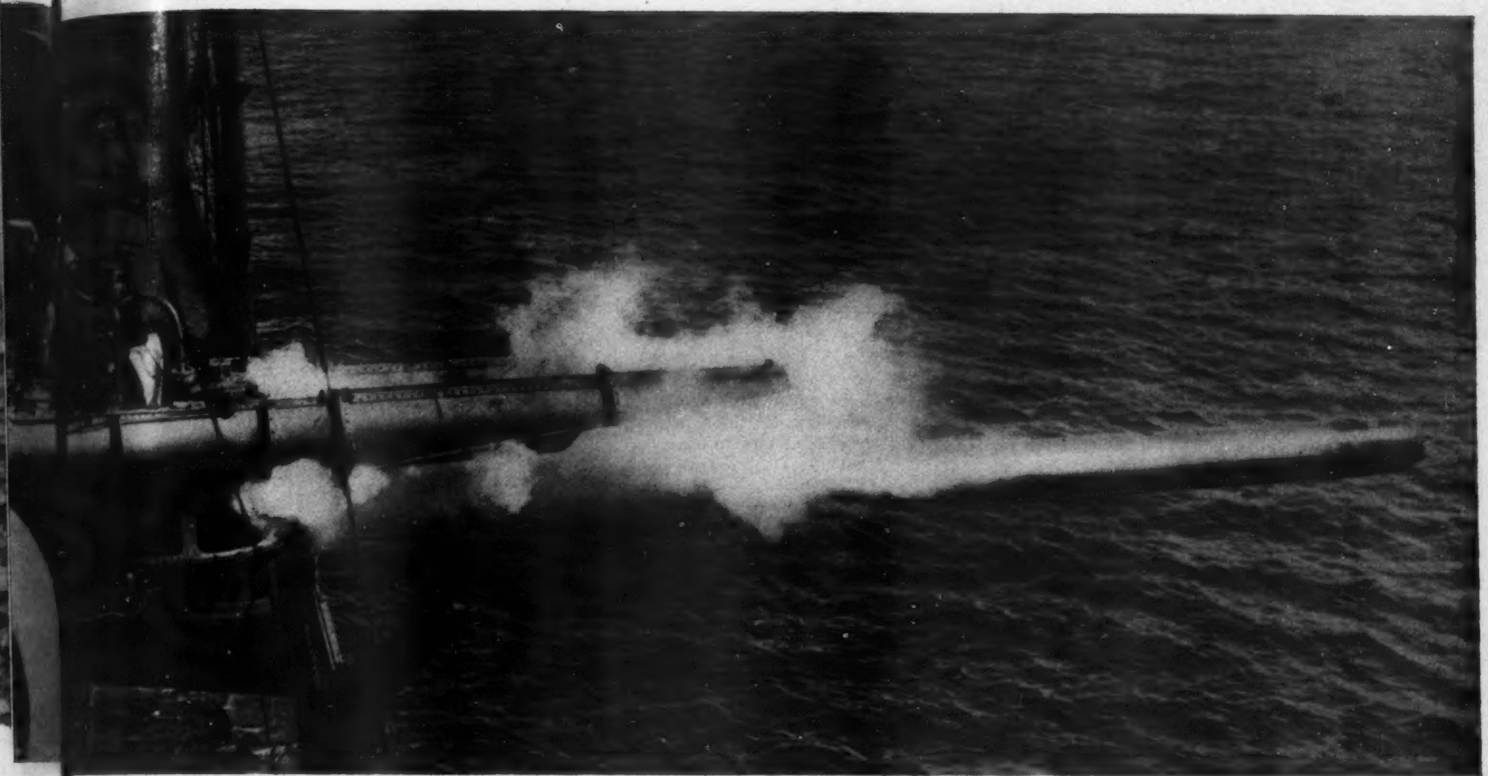
U. S. Navy Recruiting Bureau Photo

LETHAL STEEL FISH

The picture on the next page shows a torpedo being launched from one of the twin-tube mounts of a U. S. Navy destroyer during practice maneuvers. At the top of this page is a spent torpedo, after a trial run, being towed back to the vessel that fired it. When used for training purposes, the head is filled with water which, at the end of the run, is expelled by compressed air to bring the weapon to the surface so that it may be seen and recovered. A large modern torpedo may cost as much as $9,000. The view just above shows an 18-inch torpedo of the type in service prior to 1914. It is equipped with a practice head, ready for firing on the target range.

THE automobile torpedo of today owes its beginning to unsuccessful efforts to produce a small crewless, surface bomb-boat that could be guided toward an enemy ship by trailing tiller lines reaching back to a control station on shore or afloat. The craft, which never reached the operating stage, was to run under its own power and to carry at its bow a considerable explosive charge to be fired by a pistol actuated by the boat on hitting its target.

Such was the plan disclosed by Captain Luppis of the Austrian navy to Robert Whitehead, an Englishman, in 1864. At that time Whitehead, who was manager of an engineering plant at Fiume, was widely known for his ingenuity and mechanical skill; and Luppis sought him to help make the bomb-boat a practicable naval weapon. Failing to devise something that would overcome the objections of the Austrian Ministry of Marine, Whitehead then suggested to Luppis that they try to design and build a self-propelled underwater missile that could steer itself and, after launching, speed unseen toward its intended target. Nothing of that nature had ever been produced; but, undismayed by the novelty of the proposal, Luppis and Whitehead attacked the problem with the aid of a trustworthy workman and Whitehead's son, age twelve. After nearly two years of secret and continuous work, the first "fish" torpedo was offered the astonished world in December, 1866.



According to a French authority, the torpedo was about 10 feet long, had a maximum diameter of 14 inches, and a total weight of a trifle less than 300 pounds. It had a single propeller that was driven by a unique form of rotary engine; and the motive energy was compressed air stored in a small flask at a pressure of 368 pounds per square inch. There was an automatic regulator to control the cutoff of the engine so as to equalize, in a measure, the speed of the missile as the reserve pressure dropped in the air flask. The weapon attained a maximum speed of about 6 knots for a short distance. It was designed to stow 17.63 pounds of explosive in its head; and on its nose there was a percussion mechanism for firing the charge.

The hull was of spindle form and was constructed crudely of iron boiler plate. On its back and bottom, the torpedo carried a long projecting fin; and it had movable horizontal planes or diving rudders that were tilted up or down by the action of a so-called "hydrostatic plate" placed in a compartment, in communication with the sea, that subsequently became known as the balance chamber. The plate or disk was linked by connecting rods and levers with the rudders, and its movement was brought about by water pressure applied on one side and by an adjustable spring pressing against the other side. The spring could be set to control the disk down to any desired depth; and if that depth was exceeded, then the hydrostatic pressure would take control. Thus, between the two actions, the diving rudders would cause the torpedo to plunge, or to be swung so as to start it upward. Ingenious as the mechanism was, the pronounced angles alternately given the diving rudders made the weapon trace a sharp zigzag course in the vertical plane.

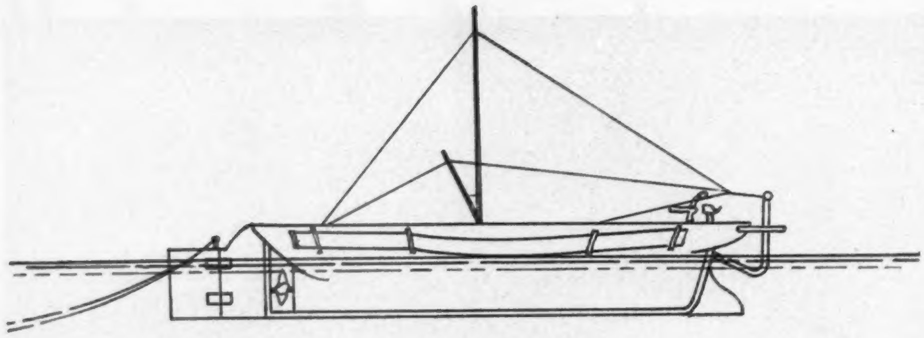
After Luppis and Whitehead had put their torpedo through its paces in the Harbor of Fiume, the Austrian Ministry of Marine organized a commission of naval experts to test the invention. The trials took place at Fiume during 1867 and 1868; and, in the end, Austria, unable to purchase the exlusive rights to the weapon, decided to adopt it for its naval service. Two Luppis-Whitehead torpedoes, probably improved forms of the original one, were submitted for those trials. The larger of the two was 14 feet 1 inch long, had a maximum diameter of 16 inches, weighed 650 pounds, and could carry 60 pounds of guncotton in its head. According to available reports, neither exceeded 6.8 knots for a short run at full speed, although the possible full range at diminishing speed is said to have been about 700 yards.

During the tests by the naval commission, the erratic vertical travel of the torpedoes met with criticism, and to overcome that fault Whitehead improved his depth-control apparatus by adding to the mechanism a pendulum hung so it could swing longitudinally and respond to any change of trim in that direction on the part of the weapon. The pendulum lessened the amplitude of the angles taken by the diving rudders when wholly controlled by the hydrostatic plate and the adjustable spring. The zigzag course became more nearly undulatory; the average speed of advance was increased; and the torpedo hit the target oftener. The combined depth-control mechanism was the carefully guarded secret of the torpedo for years, until every interested naval nation knew all about it.

After the completion of the Austrian trials, England, France, Italy, Germany, and others obtained the rights to manufacture the Whitehead torpedo. In 1869, and again in 1874, Whitehead offered his invention to the United States Government; but it was not until 1890 that the Navy Department took the initiative and approached the Whitehead Torpedo Company in Fiume. At that time, according to an official statement, there was not in our naval service a single automobile torpedo. Shortly after, the E.W. Bliss Company, of Brooklyn, N. Y., arranged to make Whitehead's for the U.S. Navy. In latter years all our torpedoes have been built in a Government plant.

Our delay in adopting the Whitehead torpedo as a basis upon which to go forward was due to various kinds of mobile torpedoes offered the U.S. Navy by many inventors. Some of these gave great promise; but for one reason or another they failed to meet the requirements imposed by continually changing conditions of naval warfare. The so-called Whitehead type has survived because of the soundness of its basic principles and its remarkable adaptability. Whitehead, by a stroke of genius, chose compressed air as his impulse medium; and compressed air is still the primary source of motive power. In the long interval, the stored pressure has mounted from 368 pounds to fully 2,850 pounds per square inch. Compressed air performs a number of essential services other than that of sending the torpedo on its way; but these were not foreseen when the first fish torpedo won recognition.

The automobile torpedo is virtually a small crewless submarine that is capable of speeding with uncanny precision toward its intended target, be it near or far. It



LUPPIS BOMB-BOAT

This unsuccessful craft, planned about 1864, led to the development of the automobile torpedo. The mast, two outrigger booms, and the fixtures at the bow were all arranged, upon making contact with an enemy ship, to trip a trigger cocked to fire an explosive in the forward part of the vessel.

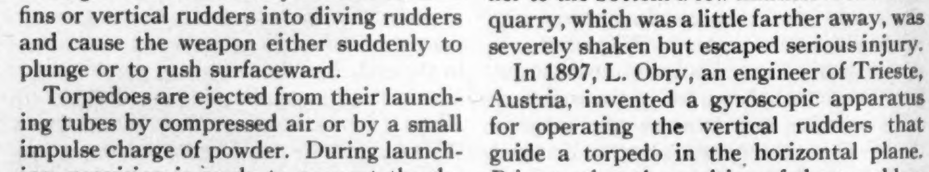
represents the cumulative work of many fertile-minded men of diversified gifts. Internally, it is subdivided into six distinctive compartments, and all the weights are so distributed that when it is in the water it is nicely balanced longitudinally, will just float, and is readily responsive to the separate sets of rudders that control it in the vertical and the horizontal plane. The foremost section, or head, contains trinitrotoluol, the high explosive that has supplanted the wet guncotton long used. The second subdivision is a beautifully fashioned, thin-walled flask of high-tensile steel capable of confining a considerable volume of air at a test pressure of fully 3,000 pounds per square inch. Next comes the immersion chamber which is in contact with the open sea and in which are the apparatus that primarily direct the movements of the two small diving rudders at the tail of the torpedo. The principal features are one or more adjustable springs, which act against the hydrostatic disk or plate up to the set depth and then yield to pressure exerted by the sea against the opposite side when the weapon has reached the predetermined depth. The plate is not directly exposed to the water because of an interposed, rubber diaphragm which presses against it. The coöperating pendulum, which is sensitive to longitudinal change of trim, tends to smooth the torpedo's course in the vertical plane, but it alone cannot now exert enough power to shift the diving rudders of torpedoes traveling far faster than they originally did. The necessary added energy was obtained in Whitehead's day by a small servomotor actuated by compressed air. It is said that even so small a pressure of air as ½ ounce applied to the slide valve of the servomotor piston will provide enough power to lift a weight of 180 pounds! Since then servomotors have been altered and improved to meet still more exacting conditions.

The fourth compartment houses the propelling machinery, and immediately rearward is the buoyancy chamber which assures the required measure of buoyancy to compensate for the torpedo's dead weight. In the same chamber may be placed certain weights to give the missile its required balance and stability as a submerged floating body. From the engine room and through a sleeve that passes from end to end of the buoyancy chamber is carried the main propelling shaft which directly drives one of the two propellers at the tail end of the weapon. The second propeller is actuated by a hollow tail shaft that envelops the main shaft and to which the latter imparts reverse motion by means of a nest of four miter gears. By revolving oppositely, the propellers thus tend to stabilize the torpedo transversely and to prevent it from turning on its own longitudinal axis—a movement that was common when it had only one propeller. Any heeling would immediately convert vertical fins or vertical rudders into diving rudders and cause the weapon either suddenly to plunge or to rush surfaceward.

Torpedoes are ejected from their launching tubes by compressed air or by a small impulse charge of powder. During launching, provision is made to prevent the derangement of the sensitively balanced pendulum and of other nicely adjusted mechanisms. The pendulum, for example, is locked until after the weapon has gone a given distance from the ship, for otherwise it might swing as the torpedo dives and shift the rudders, causing the missile to rise before attaining the proper depth. Protection is afforded another prime internal mechanism by minimizing the supply of motive air delivered to the engine until after the torpedo is completely underwater and there is no danger of wracking the machinery by having the propellers race at high speed while the weapon travels through the air from a deck tube to the sea. In addition, there is interposed between the main air flask and the power plant some form of reducing valve that feeds the air to the prime mover at a much lower pressure than that at which it is stored in the flask. This conservation of driving energy is necessary to give the missile as long a range as practicable.

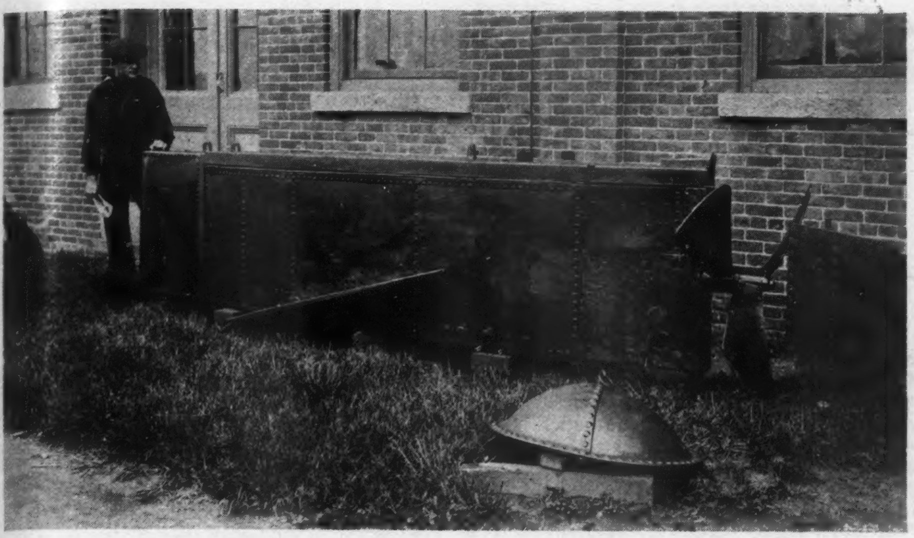
At or near the nose of every automobile torpedo there is a percussion apparatus that detonates the explosive charge in the war head on striking a target or other obstruction. The firing pin, of whatever type, is held immobile and "safe" until the weapon has been launched and has gone a fixed distance from the vessel. In most cases, the firing pin is automatically unlocked by a mechanical device, and a blow is required to make it act. During the World War, however, German torpedoes were often fitted with magnetic pistols that were excited to action when near but not necessarily touching the steel body of an enemy craft. Those pistols were often erratic in their functioning; and a torpedo, launched by the *UB-65* at an attacking allied submarine exploded so close to the German boat as to damage her fatally and to send her to the bottom a few minutes later. The quarry, which was a little farther away, was severely shaken but escaped serious injury.

In 1897, L. Obry, an engineer of Trieste, Austria, invented a gyroscopic apparatus for operating the vertical rudders that guide a torpedo in the horizontal plane. Prior to that the position of these rudders was fixed after each torpedo had been run several times over a test range toward a stationary target to determine how they should be permanently set to neutralize the error peculiar to it. The testing took place in an area of sheltered water, and the corrective adjustments were made by experts. Finally, when so compensated, the missiles were issued to naval vessels with



LUPPIS-WHITEHEAD TORPEDO

The original torpedo, first produced in 1866, ran underwater and was propelled by a compressed-air rotary engine. *A*- position of air storage tank in hull. *CV*- charging valve for admitting air to storage; *P'*- percussion point; *E*- space filled with 18 pounds of dynamite; *T*- safety lock released by a trigger just before launching; *S*- boiler-plate shell; *V,V*- longitudinal vertical fins on top and bottom of torpedo; *H*- sea connection with hydrostatic plate, one of two associate features of the diving control device; *D*- one of two diving rudders on opposite sides which could be operated through a connecting shaft and levers by the hydrostatic apparatus; *P*- propeller; *C*- a counting mechanism connected with the propeller shaft that could be set to bring the torpedo to the surface after a run of any given length; *L,L*- horizontal fins intended to hold the torpedo centered in the launching tube during expulsion.



ERICSSON DIRIGIBLE TORPEDO

Constructed in 1873, this 2,000-pound craft was made of boiler plate. It was submerged by two inclined planes, the angle of which was changed at a predetermined depth to maintain it at that level. Compressed air for both driving and steering was delivered to the missile through a trailing hose 800 feet long, and this limited its effective range to that distance. It is said that ten to twelve men were required to operate the manual compressor that supplied the air. The weapon attained a maximum speed of 3 knots. It represented one of many efforts to produce a self-propelled torpedo for our navy.

either submerged or above-water launching tubes.

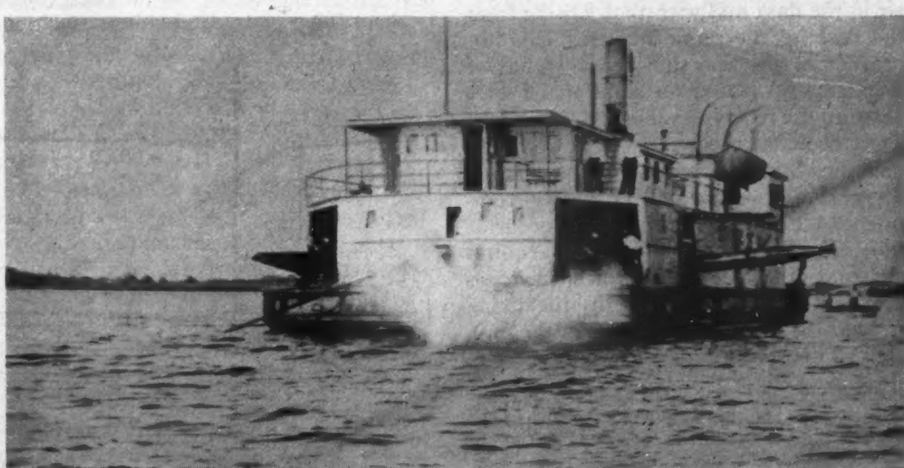
In those days even peacetime torpedo practice was none too good; and in wartime the hits were infrequent especially if both the enemy craft and the launching ship were in motion. With the introduction of the Obry gear, which is based upon the inherent impulse of a rapidly spinning flywheel or gyroscope to hold to its original plane of rotation, great improvement in performance was realized. The gyroscope was ingeniously mounted so that it would be sensitive to any shifting of the torpedo from the prescribed line and instantly open the air valve of a diminutive pneumatic steering engine capable of exerting sufficient power to swing the vertical rudders in the proper way to correct the weapon's course. The original Obry gear was spun by the sudden release of a powerful spring that gave the gyro flywheel an initial speed of fully 2,000 rpm. The mechanism was subjected to trial in the U.S. Navy about 1899.

Forty-one years ago the newest of our torpedoes had a length of 16.4 feet, a maximum diameter of nearly 18 inches, and carried an explosive charge of 132 pounds of wet guncotton. Motive air was stored in the flask at a pressure of 1,500 pounds per square inch—then considered high. The missile could cover 800 yards at an average speed of 30 knots, or 1,500 yards at an average speed of 24 knots. With the gyroscope in control, the torpedo was required to hold its depth within 15 inches for a run of 1,500 yards and to strike within 20 yards on one side or the other of the center of the target. Although the gyroscope did improve the weapon's horizontal accuracy, still the mechanism of that date had troublesome "kinks," was not generally understood by torpedomen, and was vigorously opposed by some experts. The apparatus was not sturdy, and was likely to suffer derangement when the torpedo was handled under normal service conditions. The spring that set the gyro spinning was released just before the missile was placed in the tube for launching.

While the E.W. Bliss Company was turning out torpedoes on a commercial scale, our Naval Torpedo Station was fabricating them in a smaller way and keeping the service supply in repair. Incidentally, the latter paid much attention to developments of strictly American origin. Lieut. Commander Washington I. Chambers, U.S.N., and Quarterman Machinist Moore of the Naval Torpedo Station, evolved a radically new type of gyroscopic gear. In this gear the rotor was mounted in ball bearings so as to give the gyroscope a longer period of control impulse, and the flywheel was spun by compressed air.

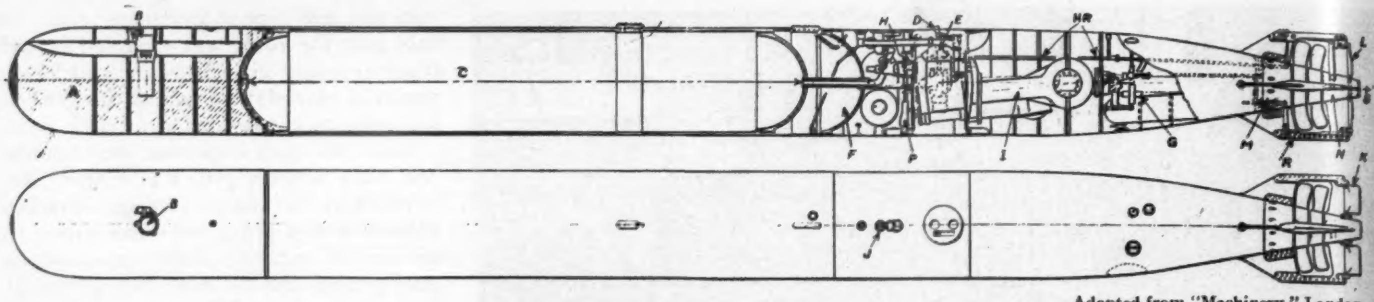
But a still more important improvement was made when a gyro was devised that could be set so that a torpedo, launched with its nose pointing anywhere within an arc of 120° away from its target, would, after getting into the water, swing through the prescribed arc as though steered by a guiding mind and then head straight for the chosen objective. This invention enables an attacking vessel to fire torpedoes from deck tubes pointing outboard from either side at an enemy dead ahead because the missiles will turn in their course and run toward it. Although the tubes do not have to be aimed at their target, still the gyro in each torpedo is aimed directly at the foe and the flywheel is so suspended in space by sustaining gimbals that the gyro can hold to its original plane of rotation while the torpedo moves about it. Gradually, the undeviating gyro exercises its sway through a pneumatic servomotor which actuates the vertical rudders. The compressed-air-driven gyro, which weighs less than 2 pounds and requires but little air to spin it, has made longer ranges possible and has tremendously bettered the accuracy of torpedoes launched from ships operating in tumbling seas.

Early in the present century, Frank M. Leavitt, associated with the E.W. Bliss Company, succeeded in increasing the speed and range of our torpedoes. Designers and builders had long sought ways to use the air, crowded in the flask of the weapon, to greater advantage. The capacity of the flask could be augmented by amplifying the diameter and the length of the torpedo; and the metallurgist helped by producing steels from which thin-walled flasks could be made that would hold air at a test pressure of 3,000 pounds. These advances satisfied only temporarily, because towards the outer limits of a torpedo's run



TORPEDO TESTING SHIP

This floating machine shop and testing craft was used by E. W. Bliss Company in putting every torpedo through preparatory runs before delivering it to the U. S. Navy.



Adapted from "Machinery," London

BRITISH WEYMOUTH TORPEDO

This torpedo has a diameter of 21 inches, a maximum speed of 48 knots, and a range of 13,000 yards at a lower speed. *A*- war head carrying a charge of 660 pounds of TNT; *B*- firing mechanism which is locked until the torpedo has run 300 yards from the launching vessel; *C*- flask of special steel for holding air at a pressure of 2,850 pounds; *D*- starting lever, which is tripped as the torpedo travels outward from the launching tube; *E*- superheater that supplies the motive fluid to the propelling engine; *F*- combined oil-and-water tank that furnishes two of the ingredients of the motive fluid; *G*- gyroscope controlling the movements of the vertical rudders that steer the torpedo in a horizontal plane; *H*- hydrostatic plate which, with the pendulum *P*, controls the horizontal rudders that maneuver the torpedo in the vertical plane; *HR*- the connecting rod between the servomotor of the hydrostatic apparatus and the levers by which the diving rudders are maneuvered; *I*- twin-cylinder horizontal engine that develops 400 hp. to drive the torpedo through the water; *J*- charging valve for admitting compressed air to the flask *C*; *K*- diving rudders; *L*- vertical rudders; *M*- servomotor that controls the vertical rudders; *N*- terminal section of the hollow cone of the torpedo; *R*- oppositely rotating twin propellers that drive the torpedo; *S*- rear end of the hollow propeller shaft through which the exhaust from the engine is discharged into the water.

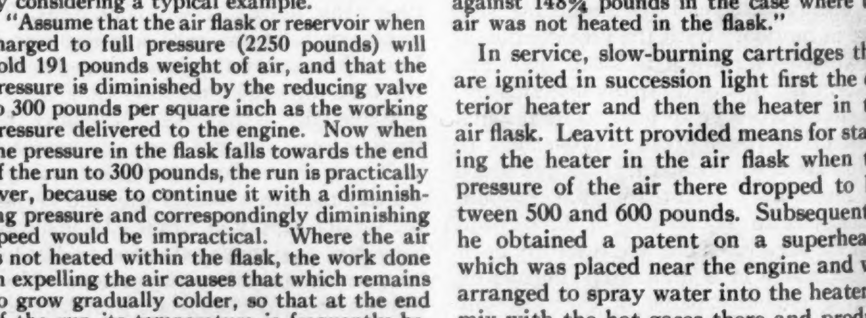
there still remained in the flask a considerable volume of air that was of too low a pressure and much too cold to drive the radial 3-cylinder reciprocating engines then in use. Leavitt hit upon the revolutionary idea of heating the air by means of an alcohol flame in the flask. The scheme seemed extremely hazardous, but the inventor showed how the flame could be controlled by the air's own pressure and regulated so as not to invite an explosion. The flame increased the useful volume and temperature of the air; and the maximum speed was thus raised to 35 knots for an 800-yard run—improving the chances of scoring a hit by reducing the time of travel.

The superheater was followed a little later by an experimental-stage turbine engine for torpedo drive, and its efficiency indicated that it could use advantageously air heated to a degree that would almost certainly ruin any reciprocating engine. Turbines capable of meeting the most exacting requirements imposed by the Navy were eventually developed, and superheating was expanded to deal both with the air in the flask and with that flowing from the flask to the prime mover. This improvement also was due to the genius of Leavitt, who placed an additional heater between the reducing valve and the engine. The reasons for this arrangement were thus described by the inventor, and incidentally reveal the dead weight of highly compressed air and the changes that occur as it is expended and the torpedo acquires corresponding buoyancy which increases the work that must be done by the diving rudders to keep the missile at the prescribed depth during a run:

"When the air is heated within the reservoir or flask the temperature imparted to the air is lowered upon the passage of the air through the reducing valve, so that the temperature is materially reduced before the air reaches the engine, and part of the added efficiency imparted by heating is lost. When the heater is placed beyond the reducing valve the air arrives at the engine with practically the same heat imparted to it in the heater, so that a greater amount of work may be obtained from a given weight of air. There is also the advantage that the hot gases do not pass through the torpedo valve system. But this external heating involves a serious loss, which is saved by placing the heater within the flask; namely, that the heat is not utilized to expel so much of the stored air towards the end of the run, so that with this system there remains a larger residue of compressed air unutilized after the run is over. This last condition may be best understood by considering a typical example.

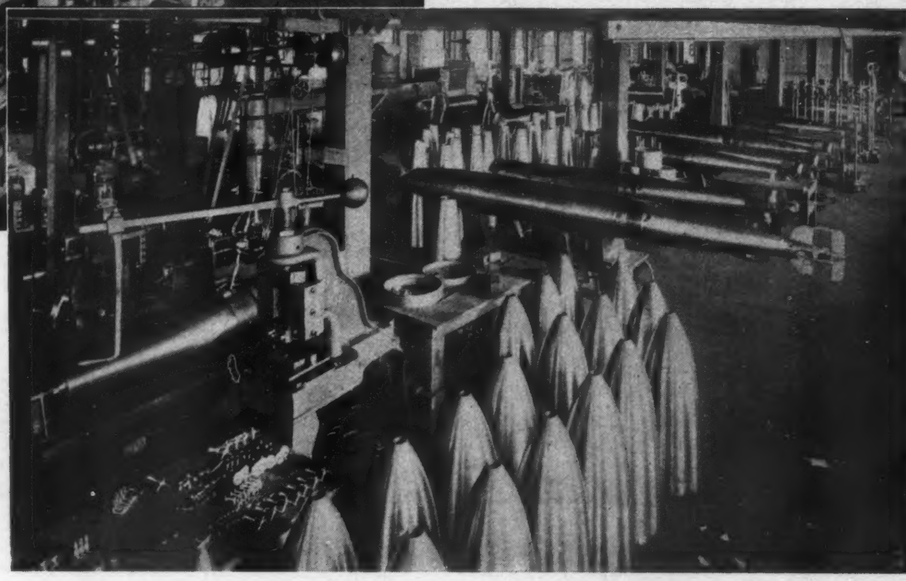
"Assume that the air flask or reservoir when charged to full pressure (2250 pounds) will hold 191 pounds weight of air, and that the pressure is diminished by the reducing valve to 300 pounds per square inch as the working pressure delivered to the engine. Now when the pressure in the flask falls towards the end of the run to 300 pounds, the run is practically over, because to continue it with a diminishing pressure and correspondingly diminishing speed would be impractical. Where the air is not heated within the flask, the work done in expelling the air causes that which remains to grow gradually colder, so that at the end of the run its temperature is frequently below zero: in practice it is found that with a final pressure of 300 pounds at the gauge, if the flask stands long enough to reabsorb the heat lost during the run, the air pressure rises to about 500 pounds. Under these conditions of the original weight of air, only 148¾ pounds have been utilized. If, on the other hand, the air is heated within the flask its final chilling is avoided, and sufficient heat can be imparted to it to expel considerably more air than if the temperature in the flask remained unchanged: in practice it is found that by heating the air to nearly 600°F., if the pressure at the end of the run is 300 pounds, then after cooling to the normal it falls to about 200 pounds, leaving only say 17 pounds weight of air in the flask, so that 174 pounds of air have been used to produce useful work, as against 148¾ pounds in the case where the air was not heated in the flask."

In service, slow-burning cartridges that are ignited in succession light first the exterior heater and then the heater in the air flask. Leavitt provided means for starting the heater in the air flask when the pressure of the air there dropped to between 500 and 600 pounds. Subsequently, he obtained a patent on a superheater which was placed near the engine and was arranged to spray water into the heater to mix with the hot gases there and produce a steamlike mixture of lower temperature which could be used as motive force for the engine and be less likely to impair the prime mover.



TORPEDO PROTECTION FOR BATTLESHIPS

These sketches illustrate some of the attempts designers have made to render battlecraft immune to vital damage from torpedoes. The heavy lines indicate armorplate. *D,B* is the double bottom, and *G,S* marks the compartments or chambers that are intended to give the explosive gases from a torpedo a chance to expand and thus to reduce their power to break deeper into the body of the vessel. The invention of the gun torpedo was designed to overcome these various defenses.



MAKING TORPEDOES

At the right are torpedoes in an advanced stage of manufacture in the E. W. Bliss Company plant where these weapons for the U. S. Navy were formerly made. Above are shown some of the delicate mechanisms, fashioned with the precision of watchmaking, that go into modern torpedoes.

Inventive minds seem to move along contemporaneously, for Gregory C. Davison, formerly of the U. S. Navy and a torpedo expert, also was granted patents in 1912 on apparatus for generating a motive fluid for automobile torpedoes. His invention lay in substituting for simple compressed air a fluid derived by burning a suitable fuel in combination with either compressed air or oxygen and then in injecting into the highly heated products of combustion a quantity of water which is converted into steam, considerably increasing the volume of impulse fluid, and incidentally lowering the temperature. That, virtually, is what is done in the largest and most formidable of the Whitehead torpedoes manufactured at the well-known Weymouth plant in England.

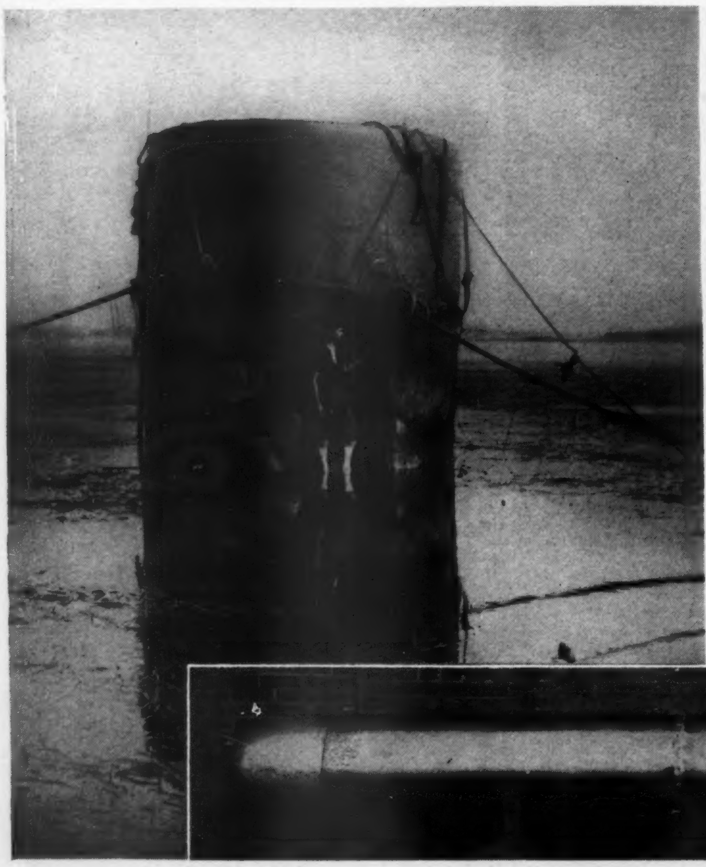
By 1917, the Navy Department had both short-range torpedoes for submarines and long-range torpedoes for destroyers and other surface vessels. Both classes were 21 inches in diameter but of different lengths—the longer weapon being about 24 feet over-all. The short-range missile could cover 4,000 yards at a speed of approximately 40 knots, and the long-range torpedo could run fully 10,000 yards at an average speed of 25 knots. About that time the navy shifted from guncotton to trinitrotoluol as an explosive charge, because TNT was easy to handle, perfectly stable, and quite as strong as guncotton. Rear Admiral Joseph Strauss, then Chief of the Bureau of Ordnance, made this disclosure about the 21-inch missile: "The greatest permissible error at 4,000 yards in the run of a torpedo is 55 yards either way (horizontally). The permissible perpendicular error prescribed for the acceptance of a torpedo is from 1.5 to 2 feet, plus or minus, in a run of 4,000 yards. . . . . . You can run the torpedo at any desired depth. They are set for 15 to 20 feet against a battleship; and to run at a depth of 4 or 5 feet against destroyers. The depth adjustment can be made quickly just before firing."

Our torpedoes have been improved intermittently since the World War, and it is safe to say that they, together with launching gears and other essential features, are unsurpassed by those of any other nation. We are not at liberty, however, to give particulars about them at this time; but a good idea of what the present-day automobile torpedo is can be gathered from details that have been made available during the past year about the 21-inch Weymouth Whitehead which is 24 feet long, weighs 3,500 pounds, carries 660 pounds of TNT in its war head, has a maximum speed of 48 knots, and is reputed to have a maximum effective range of 13,000 yards—nearly 7.4 statute miles.

The Weymouth 21-inch has in its war head a pistol with a weight so held by a spring that a considerable shock is necessary to release the striker which fires two detonators which, in turn, bring about the instantaneous and violent explosion of the large main charge. This safety device is locked until the missile has traveled about 300 yards and prevents any chance blow during handling, or the impact shock when the torpedo first hits the water, from bringing about a premature explosion. But when the pistol is free to act, even a glancing blow against the target suffices to operate it. In many torpedoes a more direct blow is necessary to cause the firing pin to do its work, and this accounts for failure to function at times.

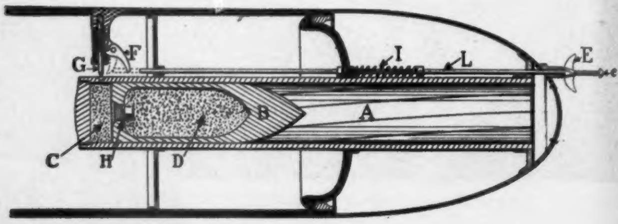
The prime mover of the Weymouth is a small 2-cylinder, double-acting engine of a horizontal type that is said to be capable of developing 400 bhp. It is driven by a mixture of hot gases resulting from the combustion of lamp oil and compressed air in a special chamber. The air is stored in the main flask at a maximum pressure of 2,850 pounds per square inch and passes through a 2-stage reducing valve before reaching the combustion chamber, where the oil and air are ignited by slow-burning cartridges brought into action by suitable means during the launching of the torpedo. The intensely hot gases produced are sprayed with water, and this creates a superheated steam that has the so-called lowered temperature of 1,292°F. This motive fluid is then fed to the engine at the pressure needed for the predetermined range and speed of the torpedo.

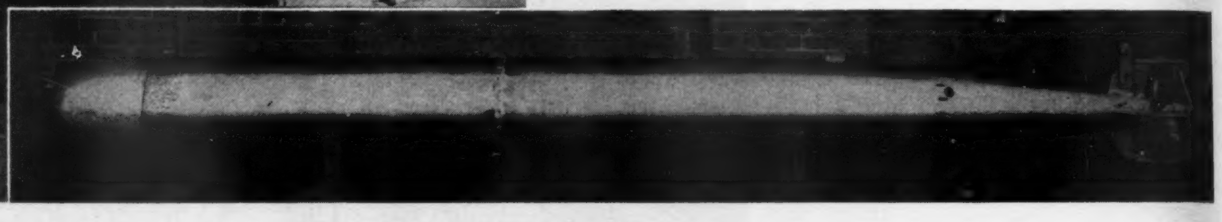
The gyroscope is given a starting speed of approximately 9,000 rpm. by a brief, initial application of jets of high-pressure



DAVIS GUN TORPEDO

This type of projectile (bottom), which may have been borrowed by Germany to penetrate the double layers of armament on modern battlecraft, was formed by lengthening a shorter torpedo and by placing a gun in its head. The drawing shows a cross section of the head. *A*- light-walled gun made of vanadium steel; *B*- 8-inch armor-piercing shell; *C*- propelling charge of powder; *D*- shell cavity filled with high explosive; *H*- time fuse; *E*- safety device which is turned and screwed outward by the advance of the torpedo through the water, thus unlocking the firing pin *L* which is held away from the trigger *F* until the tip *e* hits the target. When the trigger *F* is tripped, the pin *G* strikes the percussion fuse that fires the propulsive charge *C*. At the left is a picture, taken at low tide, that reveals the damage done to a target by a Davis gun torpedo.





air while the weapon is moving out of the launching tube. That speed is attained in a fractional part of a minute; and immediately afterward low-pressure jets accelerate the flywheel to 18,000 rpm. A pin locks the gimbal rings of the 2-pound gyro flywheel until it is making 9,000 rpm., when the pin is automatically withdrawn and the gyro speeds up, being free to exercise full control of the horizontal course of the missile.

Like all other automobile torpedoes, the operating mechanisms of the Weymouth are initially brought into action by a starting lever that is tripped as the weapon moves outward from the launching tube. The lever first admits compressed air to the gyroscope: air for the engine is not delivered until the torpedo is in the water. This control is effected by delay action. In wartime, a torpedo is arranged to sink should it miss its target and run to the end of its course: for target practice it can be set to come to the surface at the end of a predetermined run and remain afloat until recovered.

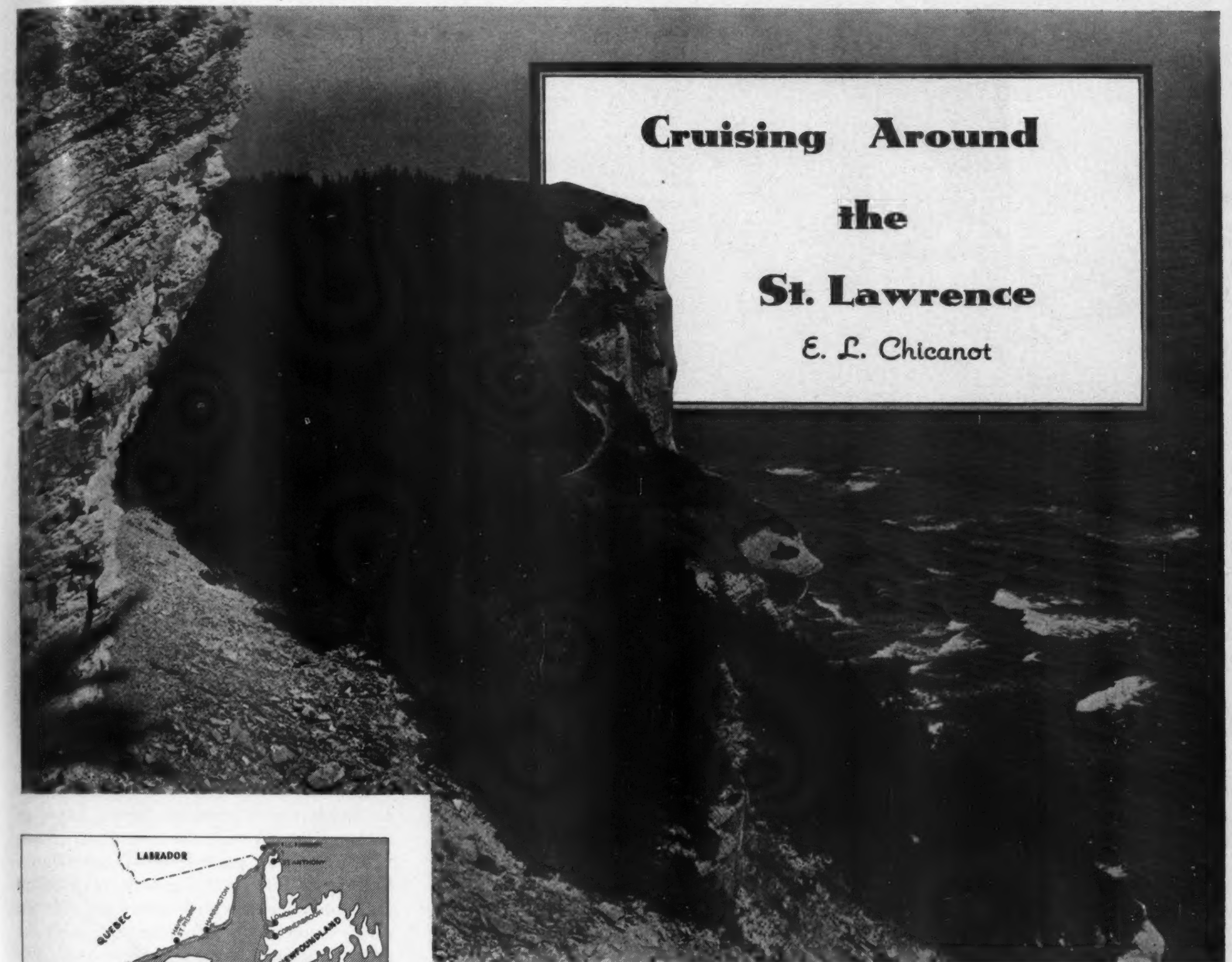
For the latter purpose the weapon's war head is removed and a practice head substituted that is given corresponding weight by filling it with water. At the end of the run—the distance of which is previously fixed by a counting mechanism actuated by the propeller shaft—a little apparatus releases compressed air, and this forces the water out of the head and gives the torpedo buoyancy to bring it to the surface and hold it there. There is an economic reason for this salvage feature, because a single large torpedo costs around $9,000.

Recently, a London dispatch reported that the Germans were probably using a new type of armor-piercing torpedo. This was offered in explanation of how some large battlecraft of the British fleet were either sunk or gravely injured by U-boat attack even though they were supposedly built with the latest of underwater defense. These facts arouse speculation as to whether the Germans have developed and are using a type of armor-piercing torpedo that has been a part of our own naval equipment for the past 30 years.

In 1910, Lieut. Commander Cleland Davis, U. S. N., was granted patents on a novel type of torpedo that was designed to mount a gun instead of an explosive charge in its war head. A weapon of this description, fitted with a gun capable of firing an 8-inch projectile, was subsequently tested. The latter was loaded with 35 pounds of Army's "Explosive D," and the missile was given sufficient velocity to drive it through 4.5 inches of steel. An older torpedo was used for the purpose and provided with a war head about 4.75 feet longer than the conventional one. This increase in length gave the weapon the added buoyancy needed to carry the gun with its projectile. The gun, with walls only ½ inch thick, was made possible by the use of the then newly developed vanadium steel. After preliminary trials in the fall of 1908, the Davis gun torpedo underwent Government tests at Hampton Roads, Va., in October, 1911. The shell did not explode, due to failure properly to time the fuse, but the projectile went completely through the target, which represented the underwater section of the side of a battleship. Accompanying illustrations show the construction and external appearance of the Davis gun torpedo and reveal its telling effect upon a target.

The automobile torpedo has been adapted for launching from the torpedo-plane, invented by Rear Admiral Bradley A. Fiske, U. S. N.; and flying craft of this kind are now in service abroad. More than likely we shall hear more about the torpedo-plane and its effectiveness before the present struggle is ended. The point to be emphasized is that the automobile torpedo has been undergoing well-nigh continual development since it was first devised by Captain Luppis and Robert Whitehead.

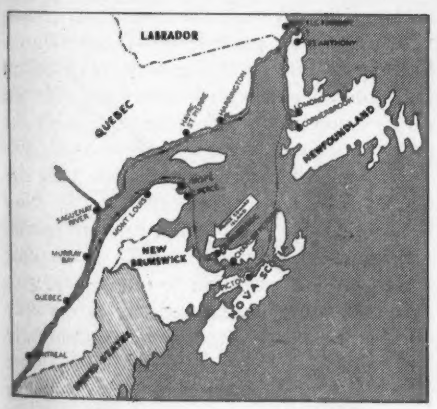
Apart from its own evolution, the automobile torpedo has brought into being various types of naval vessels that would not be in existence but for the torpedo and its ever-increasing range, speed, and power to deliver a staggering blow just where a fighting ship is least prepared to withstand attack. It has given the naval world the torpedo boat, the torpedo-boat destroyer, and the submarine. To each one, in turn, was attributed devastating powers; and "the next war" was to be totally different and many classes of ships were to become obsolete. In truth, the fighting fleets of today are more diversified in their make-up than ever before; and one would be rash to venture a prophecy regarding the future of the torpedo and the forms of the vessels that will make the most use of them.



Cruising Around the St. Lawrence

E. L. Chicanot

SHIP'S HEAD, GASPÉ BAY, QUEBEC



ROUTE OF CRUISE SHIP

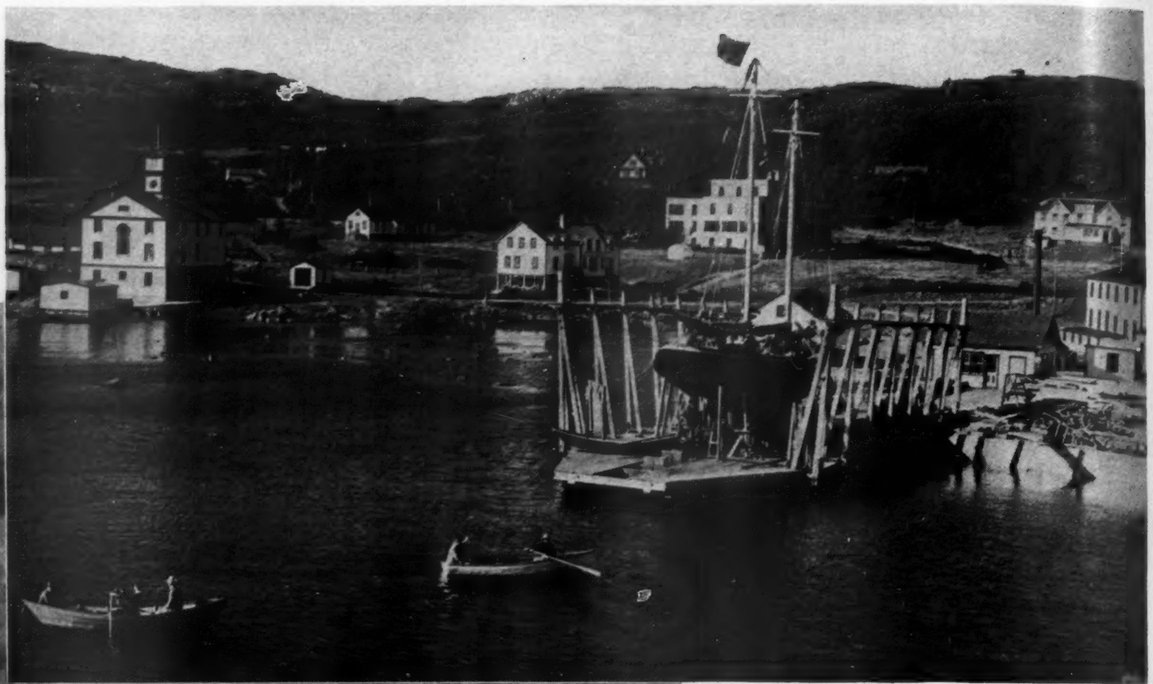
The dotted line shows the course taken on the journey described in the accompanying article, together with the principal points of interest *en route.*

TO GET away as far as possible from all that to most of us constitutes modern living, while at the same time soaking in a historic atmosphere, feasting spiritually on some of the most splendid wild beauty of the continent, and yet enjoying those things of civilization one would choose to take along, nothing can equal a cruise round the Gulf of the St. Lawrence. Several such trips, which can be fitted into the average fortnight of vacation, are available out of Montreal each summer, for commodious little vessels, miniature ocean liners, combine the business of luxury cruising with that of transporting freight from the Canadian interior to Maritime points and outposts strung along the coasts of Newfoundland and Labrador.

In many ways this excursioning is unique. Though readily accessible to the bulk of Americans, and within their holiday budget, it affords the completest detachment from the hurly-burly, the worries and routine of daily life. It carries them in the most leisurely and comfortable fashion to some of the earliest, atmospherically most mature sections of Canada and furnishes them glimpses of some of the remotest, most primitive places. Scenically the voyage runs the gamut of primal unspoiled loveliness, the twelve days of panorama duplicating virtually every kind of landscape that Europe can offer. In the luxury of shipboard life one never relaxes hold upon civilization; and for polar variety the trip can scarcely be rivaled.

Of the journey from Montreal to Quebec but little needs to be said, for this first stage of the gulf cruise is world famous and enjoyed by millions of vacationists every year. Along the banks of the St. Lawrence River, clearly visible at all times between the two cities, are innumerable settlements—miniature worlds which have been developing for nearly 400 years and which few countries can equal in picturesqueness. Village after village, its houses white-walled and red-roofed, topped by the spire of its imposing church, delights the eye of the traveler as he floats along on tranquil waters. The cruise ship comes to its first halt beneath the frowning crags of the Heights of Abraham and the towering medieval hostelry of the Chateau Frontenac. The departure of the steamer from Quebec is a gala event. Gay paper streamers strung from rail to shore snap, and the ship's orchestra blares away cheerfully as it pulls away from the wharf and threads its way among the traffic out of the busy harbor.

After gliding past that unspoiled bit of beauty, the Isle of Orleans—paradise of poets and painters—the river widens perceptibly until the gradually dimming southern shore vanishes. But before plunging boldly into the realm of simplicity and primitiveness ahead there is another touch with the superlative in modern inns as the castlelike Manoir Richelieu, set high up on



NEWFOUNDLAND VIEWS

The lower picture shows a cruise ship of the Clarke Steamship Company at Lomond. The other view is of St. Anthony, a Grenfell Mission point in Newfoundland.

the cliffs at Murray Bay, comes into view. A short while later the vessel has pulled in at the little wharf and passengers are going ashore to spend a few hours sight-seeing at this famous resort which features the summer homes of many eminent Americans and Canadians, inspecting the historic collections of the stately Manoir, and walking or driving to the many quaint French-Canadian communities within reach.

During the night the steamer crosses the river, which now has all the appearance of the open sea, and morning shows it skirting the south shore along the coast of Gaspé, a region which, though discovered 400 years ago, has but recently come into justifiable popularity for its impressive ruggedness and wild beauty. High cliffs of awing grandeur constitute the south shore, bays and harbors being few until the peninsula is rounded. Such villages as there are, with their primitive facilities, are accessible only under the most favorable conditions, and a scheduled stop at Mont Louis, a typical Gaspé fishing and lumbering hamlet, frequently has to be foregone.

Then comes one of the loveliest sections of the cruise. Just as one is beginning fully to appreciate a landscape somewhat less harsh, the vessel enters the Bay of Gaspé into which Jacques Cartier sailed in the summer of 1534, taking possession of the country in the name of the French king and setting up a wooden cross where the Town of Gaspé now snuggles. There is always considerable freight to be unloaded at this point, and an interesting time can be spent on shore visiting the little burg and viewing the imposing stone cross whose erection in 1934, to celebrate the four hundredth anniversary of Cartier's landing, was an international ceremony.

A very enjoyable day follows the departure from this historic town as the steamer hugs a shore that is becoming less rugged and, if possible, more beautiful, indented with many picturesque bays each with its little cluster of homes. It is impossible ever to forget the Hamlet of Percé, haunt of artists from all over the continent. Bonaventure Island, passed shortly afterwards, likewise is unforgettable with its clouds of gulls and other sea birds swarming over the rocky eminence and covering the sides like patches of snow. Night closes in as we proceed along the lovely and gentle Baie des Chaleurs and down between the New Brunswick shore and Prince Edward Island.

Seen over a broad stretch of rippling water, no one could fail to fall in love with Prince Edward Island, and one can readily understand how it has come to be familiarly known as The Garden of the Gulf. After the severe, at times forbidding, coast line left behind, it reposes there in all its delicate greenness, so tranquil, friendly, and inviting. Prince Edward Island is as old as known Canada, having been glimpsed by Cartier the same summer he landed at Gaspé, though he mistook it for part of the mainland. It is therefore mellowed by time, having shared in both the French and British regimes, of which it furnishes evidences on every side. Its calm, pastoral countryside is full of quaint villages, meccas for the antique hunter.

The schedule of the cruise, which is apparently fixed by the amount of freight to be handled, permits several hours ashore at the two principal centers of Summerside and Charlottetown. The former, though a delightfully sleepy little town, is the island's most active business hub. It is entirely surrounded by fox farms: one of the distinctions of Prince Edward Island being

that it gave birth to the domestic fur-farming industry. The capital of Charlottetown, with its wide tree-lined avenues and spacious grassy squares, has many attractions for the visitor from more modern, bustling spheres. Its air is serene, its pace leisurely, and in the Parliament Buildings is the room where the fathers of the Canadian Confederation first met.

The next and only port of call in the lovely Province of Nova Scotia is historic Pictou. Innumerable fishing vessels dot the harbor as our ship puts in, and before us, with several churches looming over all, rise the densely shaded streets of the small town running steeply up a series of hills. Pictou has the world distinction of being the center of the world's largest lobster fisheries. One recollects that the *Royal William* sailed from there in 1833, making the first Atlantic crossing entirely under steam. The place has many more fascinations for the intellectual, the antiquarian, the artist, and the nature lover. While freight is being unloaded, entrancing hours may be spent wandering through the narrow streets (some lined with poplars brought by early settlers from France) with their quaint houses, strolling beyond into the tranquil countryside, or rambling along the waterfront hobnobbing with fishermen busy about their boats and traps.

The following day is the only one spent entirely out of sight of land, as the steamer makes its longest jump past Cape Breton Island and Cabot Strait to Newfoundland. Thus far our journeying has been on calm, sheltered river water, but now we reach the only stage of the trip during which a little roughness and a foretaste of real sea travel may be experienced. It is really no more than a little rolling and pitching as the stout vessel plows through white-capped waves—zestful for those who enjoy a bit of a swell and an exhilarating and breezy day on the open deck, but apt to confine below those who from the outset fear that *mal-de-mer* is the inevitable concomitant of a ship cruise.

NATIVE OVEN

This sturdy French-Canadian woman is standing in front of the stone oven in which she does her baking. The location is near Murray Bay, Quebec.

Newfoundland, though famed among connoisseurs for its rugged wild beauty, is insufficiently known in this respect among the general run of holidaymakers. The aesthete will find it difficult to leave the deck for the grandeur of the scenery as the vessel steams along the coast. The fierce, awing barrier of towering cliffs is periodically broken by long graceful fiords or wide tranquil bays in which unsuspected villages nestle. They are the only signs of life encountered except for the occasional cabin of a lighthouse or fog-signal keeper that is perched high upon a precipitous rock. The ship moves up and around some of these calm indentations solely for the feast of beauty they provide, and one reluctantly leaves behind some picturesque little group of homes and their simple inhabitants growing faint against the background of a glorious northern sunset. There are one or two stops in Newfoundland at small but stable and well-developed towns where giant industries are busy turning the island's lavish timber into pulp and paper for export. Here, while the vessel discharges its cargo and loads up again, an opportunity is afforded for plunging into the wild country beyond, reveling in the intoxicating northern air, or enjoying the peculiar vegetation and flowers unknown to more southerly climes.

An interesting feature of the cruise in

Canadian National Railways Photo

CROSS MARKING CARTIER'S LANDING

This picture was taken in 1934 at the dedication of a stone cross in the Town of Gaspé to commemorate the four-hundredth anniversary of the arrival there of Jacques Cartier, French navigator. Cartier was seeking a northwest passage to the East. He placed a wooden cross at this point and took possession of the country in the name of the French king.

CHARLOTTETOWN

This is the capital of Prince Edward Island, Canada's smallest province. The city is the business hub of the island and the center of an extensive fox-farming area.

both Newfoundland and Labrador are the visits to posts of the famed Grenfell Missions. What Doctor Grenfell and his associates have accomplished for these northern dwellers in mitigating their hard lives and watching over their health is too well known to require iteration. They are, however, so much a part of the romance of the mystic North that there is a thrill in being able to meet the doctors and nurses engaged in this magnificent work, to see the splendidly equipped hospitals, to mingle and talk with the simple, hardy inhabitants of these bleak settlements, and to purchase the really fine products of the handicrafts they have been taught. Such occasions are no less gala days to these isolated people, who welcome the tourists with the greatest possible cordiality.

The change from Newfoundland to the Labrador coast is scarcely discernible, so similar are the shore lines in severity and bleakness. Here is life at its rawest and in its most forbidding aspect. Some of the fishing villages at which stops are made are mere collections of rocks, without signs of vegetation. The inhabitants exchange the produce of the sea for other necessities, for which they depend on the periodical visits of these steamers from Montreal. At some of the places it is impossible for the cruise ship to put into land, and fishermen come out in their boats to take the passengers off. By contrast, similar fishing centers farther up the St. Lawrence but still in Quebec Labrador are thriving attractive settlements with delightful sandy beaches.

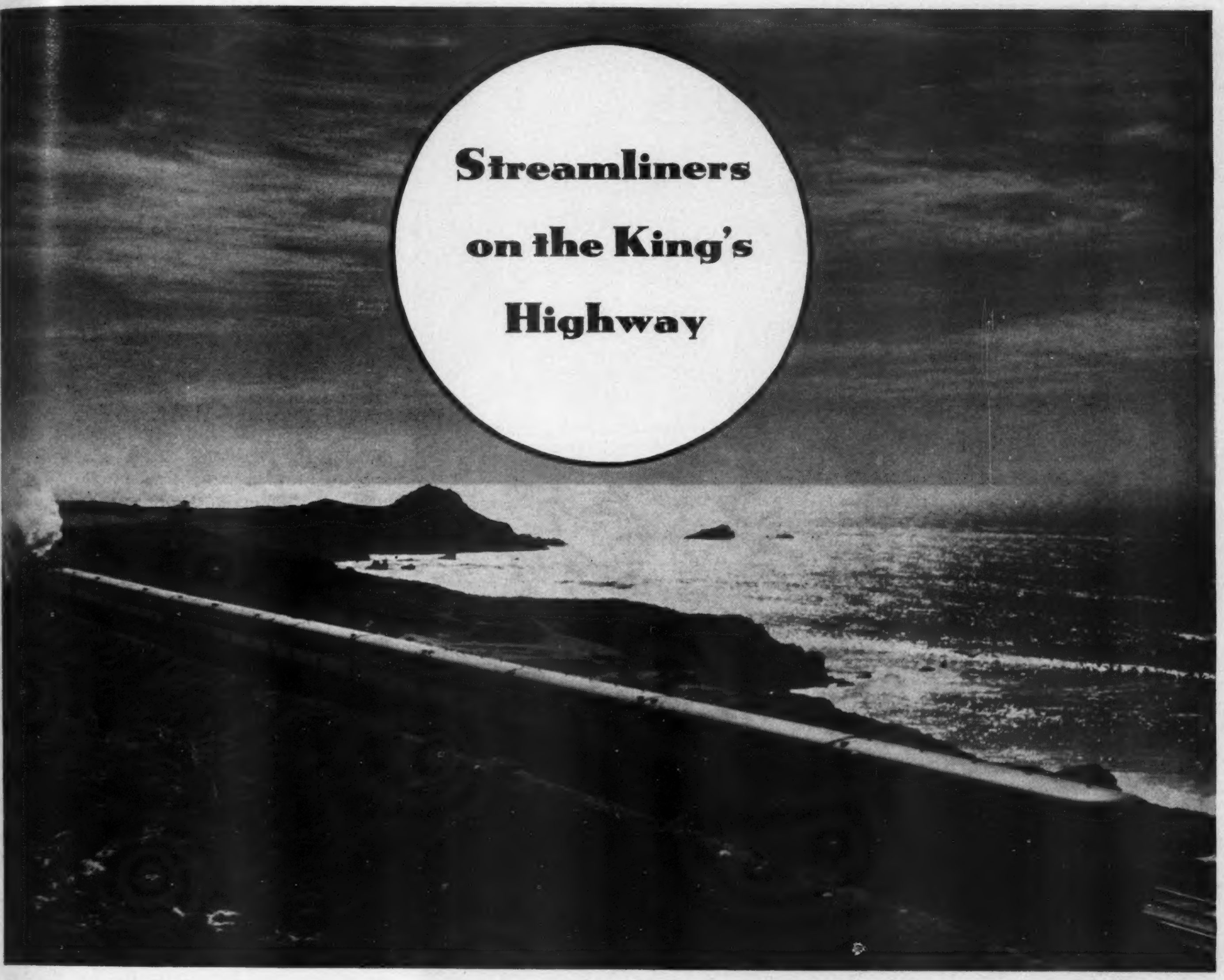
Excursions at these points are very enjoyable, for everyone, whether a descendant of Scotch migrants from Newfoundland or French Canadians, is exceedingly cordial and welcoming. Before you have proceeded very far, several youngsters will have attached themselves to you, anxious to do the honors and to lure you into their respective homes. It is pleasant in the heady northern air to stroll along the cabin-fringed beach, to see the fishermen departing or returning, to attempt to make friends with the husky dogs chained beside every home, to study the peculiar vegetation and floral life. Rapidly, any pity one has been inclined to entertain for these people living in such isolated regions vanishes, for they are surprisingly healthy and cheerful, the children intelligent and bright, a sheer delight to be with.

Gradually the craft makes its way back along the northern shore of the St. Lawrence, the river steadily narrowing, and there is just one more new scenic thrill before the holidaymakers are back at Quebec and on their way to Montreal. This is the trip up the Saguenay as far as capes Trinity and Eternity. Turning out of the St. Lawrence, the vessel glides up the vast reaches of the famed mountain-walled stream to pause under the stupendous capes, magnificent pieces of Nature's handiwork. The siren reëchoes from cliff to cliff before the ship turns back slowly to the mother river. In the evening it passes old and quaint Tadoussac, arriving the next morning at the ancient capital, the end of the cruise.

One cannot but admit that it was a fascinating tour, well off the beaten track of conventional journeying. Each day provided something unusual and unexpected in addition to the endless feast of coastal scenery and intriguing excursions ashore. On one an iceberg or several of them were sighted: on another a school of whales sported well within view. On Thursday a fishing vessel was hailed at its task and a fresh finny supply for Friday's meals taken aboard. We visited an island which was one gigantic fox ranch; we saw more husky dogs than we ever expected to encounter, as well as strange birds, flowers, and other unusual forms of wild life. Some nights the heavens staged glorious displays of northern lights; and we observed how the hardy people of these romantic outposts live, talked with them, and entered into their lives.

Best of all, we were in an entirely different world—managed temporarily to get out of the squirrel cage we tread not only in our work but in our recreation. There was little to remind us of our ordinary everyday existence, for we were bereft of newspaper and radio most of the time. But we lacked none of the essential things of civilization, for the luxury of ship life, of which we were largely unconscious because it never obtruded, enabled us fully to enjoy Nature as she reveals herself in the little known Northland.

Streamliners on the King's Highway



SEASIDE SILHOUETTE

One of the Southern Pacific's "Daylights" skirting the shore of the Pacific Ocean *en route* from San Francisco to Los Angeles. One of the principal attractions of these fast, streamlined trains is the scenic appeal of the country they traverse.

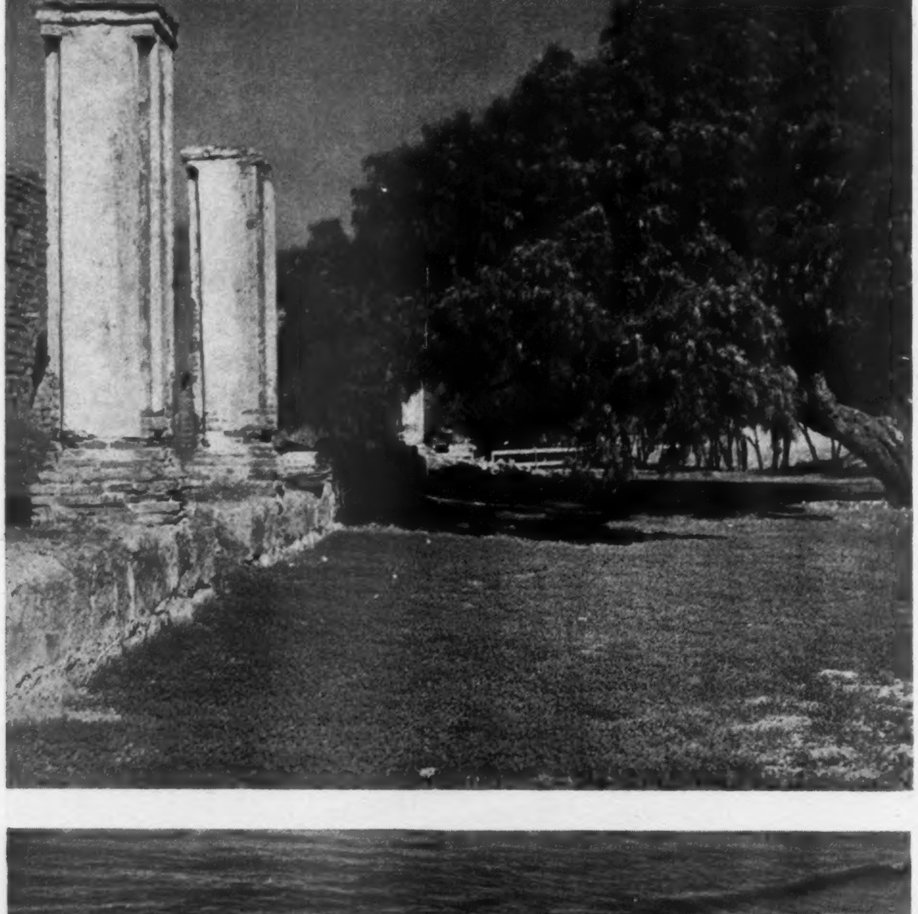
L. A. Luther

NATIVE sons were scarce in California in 1853; but the state even then had begun to produce notable boosters among her adopted children. These no doubt found special satisfaction that year in the newly inaugurated Los Angeles-to-San Francisco stage service, which made it possible to visit the Golden Gate and the gold diggings without spending a couple of weeks or more *en route* riding either a horse or a squeaking, wooden-axled cart on the day-long journeys between missions along El Camino Real. Of course Black Bart, Joaquin Murieta, and other gentry of the mask and gun who sought to muscle in on the gold boom had to be reckoned with, and rain put the stage out of the running as effectually as it had the ox cart.

Even good stage service was slow in coming to this section of California, chosen by the padres for their "King's Highway" and missions. The gold-hungry horde debarking at San Francisco sought quick transportation to its particular rendezvous with Fortune, so that roads leading to popular mining districts took precedence over older trails through vast Spanish ranchos and hide and tallow bartering towns along the coast. The present size and cosmopolitan tempo of one of these towns, Los Angeles, makes us incredulous that it was then "an adobe village on a great plain, surrounded by herds of cattle." Yet one of the state's present assets is that the coast country has retained much of that Arcadian atmosphere. Santa Barbara annually invites actors and industrialists to don gay fiesta costumes and join ranchers and descendants of old Spanish-American families in recreating the life and pageantry of colonial days. Monterey, where English, Yankee, Russian, and Spanish colonizers met near the old presidio to roister and to spy out and spar for footholds along the Pacific, has been preserved in setting and architecture, and is our best example of an old Spanish-American town. And California has recently begun properly to treasure as historic shrines the adobe mission buildings, some of which have fallen partly or entirely into ruin.

Visitors to the Golden Gate Exposition this year need exhibit none of the endurance of the forty-niners, for terrors of mud and road agents and cold, cheerless inns have long since passed. But they may like to recall that early-day ships took a full six months to go from New York to San Francisco around the Horn; that this was cut by the record-breaking clippers to 89 days; that the coming of steam and the Panama Canal shortened the trip to fifteen days; and that the first railroad required a week or so to make the journey while now, by flashing streamlined trains, it is a matter of hours.

The fact that the far distances of the West were the last to be spanned by rails makes it perhaps a matter of note that managements of western roads have led the field in modernization, and especially in offering low rates for travel in light, fast, streamlined trains. Among the best known of these are the Daylight Limiteds operated twice each way daily between San Francisco and the beautiful new Union Pas-



TRANQUILLITY AND TURMOIL

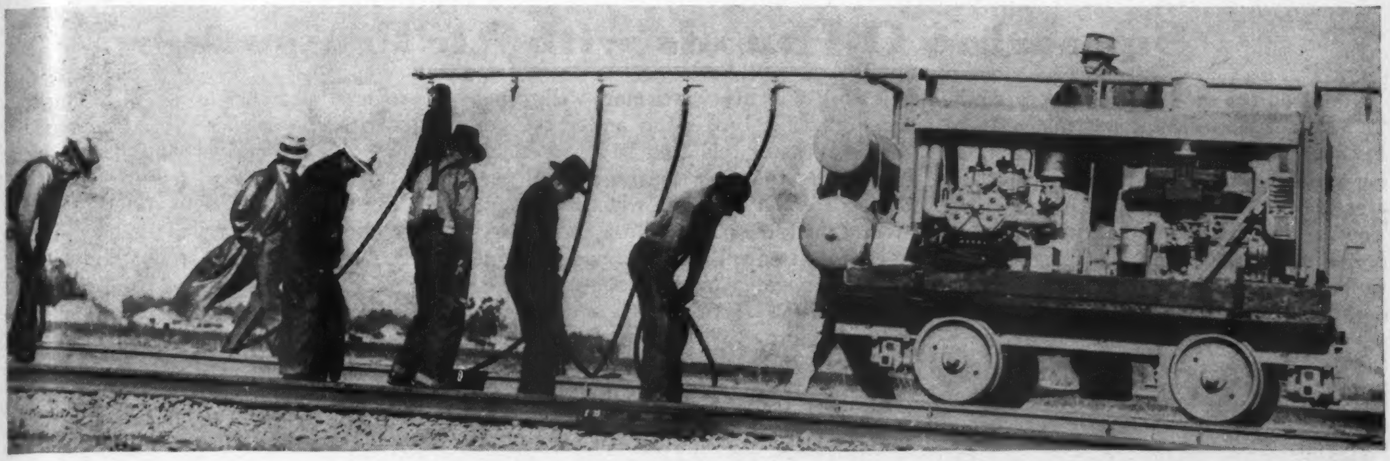
When Los Angeles was but a village, the missions of the Spanish padres at various points along the coast were outstanding structures. Crumbling pillars and a pepper tree were about all that remained of Mission La Purisma (top) until restoration was undertaken by a CCC troop. Native materials were exclusively employed to rebuild adobe walls and the red roof and floor tiles. The original water supply and fountains have been put back in service and the landscaping given, as nearly as possible, its original appearance. To enable trains to run near the ocean in sections of scenic beauty, heavy reinforced-concrete walls have been reared to protect tracks from wave action. One of these walls, near Sacate, is shown nearing completion behind a shielding cofferdam.

senger Terminal in Los Angeles. The panoramas of the Coast Route—in which the last spike was driven in 1901—have lured large numbers of the Southern Pacific's out-of-state guests to spend a memorable day on the daylight ride between the coast cities rather than use one of the several fine overnight coast or San Joaquin Valley Line trains. And the fact that natural beauty—alternating vistas of blue, breaker-fringed ocean, and liveoak-covered hills—is no less appealing to modern travelers than to eighteenth-century padres doubtless accounts for the ability of this road to give so much in speed and luxury for so little: the round-trip fare is $10.80, one way $6.00 in chair car.

This service was inaugurated in 1937 with one morning train each way daily, and during the peak of the 1939 season it frequently ran in three, occasionally in four, sections. To make this daylight ride available to greater numbers, to provide more latitude in making train connections, and to give business people a half day in the coast cities before boarding trains, a two-train-each-way service was begun on March 30 of this year. Running time has been further reduced: a 14-car streamliner leaves both Los Angeles and San Francisco at 8:15 a. m. and arrives at the opposite terminal at 5:45 p. m., and a similar train leaves each city at twelve noon and arrives at 9:40 p. m.

All four trains used are virtually identical; but the two delivered last year have automatic baggage elevators, loud-speaker systems (since added to the older trains because of its popularity as a means of calling the attention of passengers to scenic and historic highlights), and other features such as refrigerated compartments for the formula bottles of infant travelers. The new trains also have their sparkling, modern kitchens occupying an entire air-conditioned car, with the connecting low-cost coffee-shop car ahead seating 80 passengers and the regular diner behind accommodating 72. They have 418 salable seats, and for the general use of passengers there are 263 seats, including those in a spacious tavern car containing a smartly appointed bar.

All trains were built by the Pullman-Standard Car Company after a design embodying a low center of gravity, alloy-steel frames, and sheathing of aluminum and stainless steel to reduce the weight about 30 per cent, as compared with that of a conventional steel coach. Axles are heat treated, and car ends are carried on triple-bolster trucks, with trucks of adjoining cars articulated and secured by tight-lock couplers and rubber draft gears to minimize slack. Pneumatic clasp brakes are electrically actuated and automatically governed by the speed of the train, and assure quick but smooth stops. The $1,200,000 cost of each train and engine is reflected in their exterior appearance and their interior appointments. Gay red, yellow, and black stripes on the outside combine with a lower skirting over the running gear and rubber



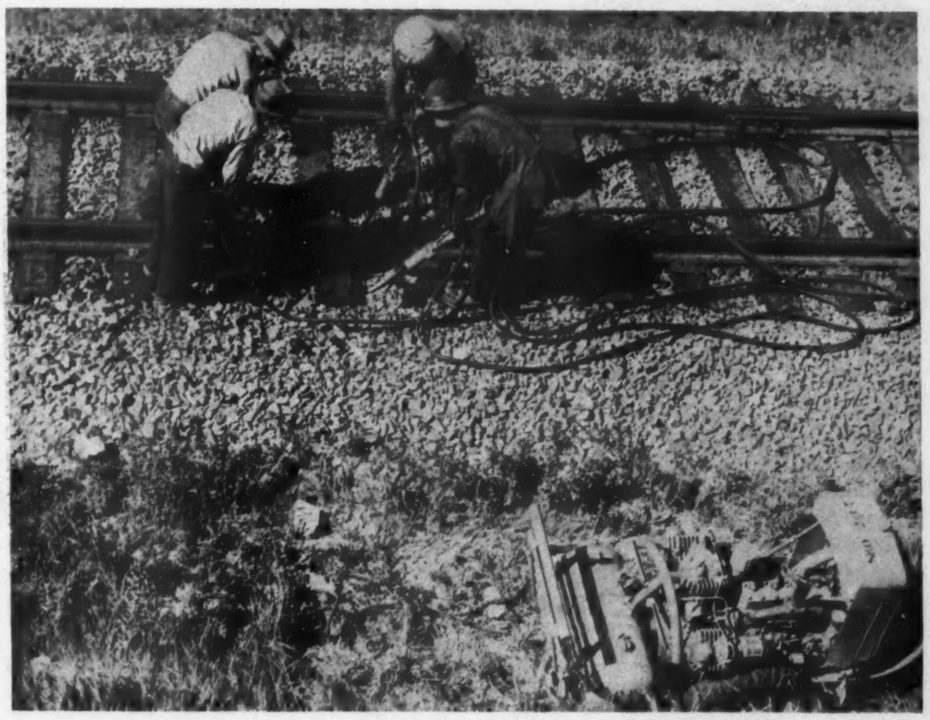
diaphragms between cars to make the trains look tubular.

The interiors of the cars are treated as architectural units, the varied color scheme of the walls and upholstery of each harmonizing with that of all the others in the assembled train. Modern engineering has provided a $5\frac{1}{4}$-inch greater inside width, as compared with standard steel cars. Windows are unusually wide, and cork and other insulating materials in floors and walls, together with plywood interiors, serve to reduce noise and contribute to air-conditioning efficiency. These Daylight Limiteds are pulled by 4-8-4 Type GS3 streamlined, oil-burning Lima locomotives each having an over-all length of 110 feet $3\frac{3}{4}$ inches. The 80-inch drivers are counterweighted for speeds up to 90 mph., and boiler pressure of 280 pounds is used in 26x32-inch cylinders.

The terrain along the Pacific Coast is rugged, and the water-level rail route has to negotiate the Coast Range that tends to swing east and west at inconvenient angles. Considering the Cuesta and the Santa Susanna Pass crossings, other inescapable curvatures and grades, several stops made *en route*, and necessary speed reductions through the considerable urban and suburban territories traversed, an average speed of nearly 50 mph. for the 471 miles between terminals is a remarkable performance and calls for good railroading not only in train operation but in track maintenance.

In working out these fast schedules, some revisions were made in signaling track circuits, and 300 speed boards were installed showing permissible speeds at curves and in other restricted zones. Curves were realigned, and elevation or "bank" changed in accordance with speed requirements. Numerous siding extensions were made to facilitate operation; and that there was a tendency to build from the ground up is evidenced by the attention given to width and stability of subgrade, quality of ballast, and by the fact that all the trackage is now made up of heavy rails—112 or 131 pounds per yard.

The engineering staff has combined much careful engineering with experimentation in the construction of massive, reinforced-concrete sea walls to protect the roadbed against wave action on that stretch of the line whose nearness to the ocean contributes so much to the scenic appeal of the route. These walls are carried down well below the shore line, and at one point, where footings of sufficient stability could not be found, an extensive section on heavy steel piling is keyed in. The numerous high steel trestles spanning picturesque canyons, and all other bridge structures have been reinforced to eliminate speed restrictions.



IMPROVING TRACK

Providing a firm and uniform bearing for ties is a Southern Pacific maintenance practice. A compact Ingersoll-Rand air-cooled compressor on a narrow-tread pneumatic mounting (lower view) supplies air for tie tampers used by a section gang. A larger rail-car model (top) furnishes energy for operating spike drivers employed in laying new rail of heavier section.

Critical scrutiny of the track structure, and especially of line and surface, has been one of the less apparent but vital factors responsible for the pleasure and safety on these fast runs. Machinery is employed extensively in maintenance and betterment work by the Southern Pacific Company, and among the devices that have contributed directly to riding comfort are numerous arc welders which recondition rail joints. Other mechanical units recently employed to supplement hand labor are 33 pneumatic-tired, 4-tool, air-operated tie tampers called Spottampers. These have been moved about among the section maintenance gangs to fit in with their working schedules and to make the best use of the machines. Another precaution taken by the Southern Pacific to assure the safety of these streamliners is periodically to run a rail-detector car over the entire system. By means of slow-moving brush contacts, electric currents are passed through the rails and serve to locate and mark interior defects long before they can be detected by visual inspection.

Squeezing Oil Sands with Air Pressure

AMONG the secondary recovery methods now being employed in Ohio and Pennsylvania stripper oil fields, one showing outstanding merit in low-production areas is a selective system of repressuring. The principle is to build up sufficient air pressure in porous sections of an oil sand to force out deposits which have been pushed back against natural sand barriers by former recovery methods and held there. In the parlance of the field this is known as "sand-squeezing."

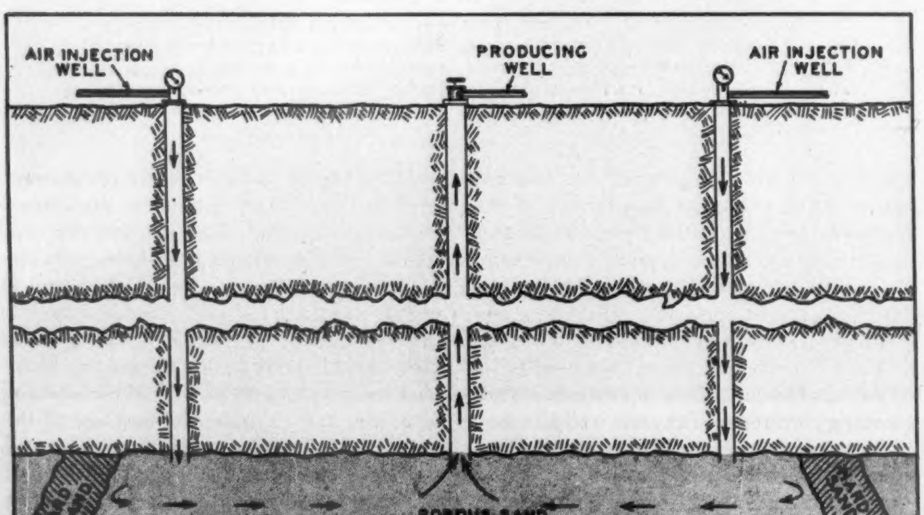
In many of the districts where selective repressuring is being practiced successfully, air pressure has been used in a general way almost continuously since 1920. During this time scores of wells have been abandoned because of air channels in the sand which make it impossible to build up enough pressure to lift the fluid to producing wells. The operator in taking over a recovery project recognizes this fact, and his aim is to fill the channels with oil instead of air. He knows by experience that his pay sand is porous, but that its porosity is interrupted at irregular intervals by faults, or hard, flinty spots so close grained that neither gas nor fluid can pass through them. He knows also that very little attention was given to these natural sand barriers when compressed air was originally applied, and that, inasmuch as the air can filter but slowly if at all through these formations, it is reasonable to assume that quantities of oil have been dammed up by them. His ambition is to force such reserves of oil into porous sections of sand with compressed air coming from two or more directions.

From records of the original drilling operations, which have been kept with fair accuracy in most cases, the first step in this work of recovery is to mark wells which have shown a broken up and flinty pay sand. Wells of this kind have invariably been drilled in or very near a natural sand barrier. When two such wells are discovered in the same pay sand, the casing head of each is fitted with an air-intake pipe and a pressure gauge and arrangements are made to force air down into each hole at the same time. The compressor used for the purpose is of the stationary, gas-engine-driven type commonly found in the oil country and from which air is conveyed through pipe lines to the wells. Recently, however, a portable driven by a fuel-oil engine has come into favor by reason of the fact that the supplies of natural gas in many stripper fields have become exhausted.

The operator's idea in starting air down both barrier wells simultaneously is to build up pressure behind whatever fluid reserves are lodged against the sand barriers. As the air cannot escape by way of the latter, the accumulations of oil are gradually pushed from opposite directions toward and into the central and porous sections of the sand. The wells within this area are then opened and pumped vigorously. In many places it is possible to build up sufficient pressure to flow the wells artificially into storage tanks, thus eliminating the expense of pumping equipment. Thousands of barrels of oil are being reclaimed in this manner from districts that were believed to have been pumped dry. The time required for squeezing out or exhausting such an area depends upon the sand's porosity and its capacity for taking air. Production may continue for from one to three years.

In repressuring a field there are often discovered stretches of virgin sand which have escaped former recovery methods because of the presence of sand barriers. One such stretch was recently found in an Ohio district which has been "aired" continuously for twenty years. It is now making a recovery production of 250 barrels of oil per month. It is also being learned that pockets and reservoirs of oil which have been formed along the edges of a pay sand by regular pressuring can, in many instances, be drained out and reclaimed by this 2-way application of compressed air between barriers.

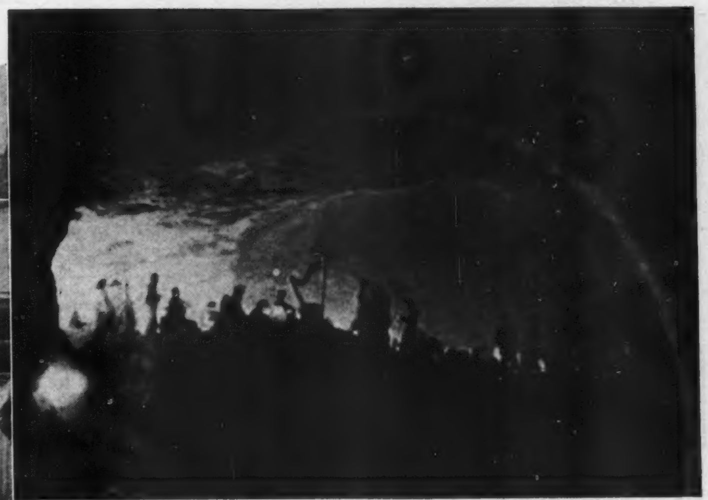
As the success of any recovery method is determined largely by the cost of production, the operator considers this factor very carefully before starting on a project. According to tables recently compiled by oil-field engineers, repressuring by air can be accomplished at one-tenth the cost of water-flooding and one-third that of pressuring with natural gas when the gas must be piped in from outside sources. It is less expensive and more effective than with steam or explosives. These estimates apply to sections where many of the original wells remain open. Where redrilling is necessary, costs are materially increased. But here again the user of air has an advantage. Newly drilled wells for the admission of air require neither explosives nor cleaning out, and in most districts can be completed for less than $1 a foot. Modern oil-field compressors are capable of handling from three to ten sand-squeezing jobs at one time; and when not fully occupied in this way, the air they supply is utilized in pipe-cleaning, casing-pulling, jetting, and similar operations about the oil lease.



SELECTIVE REPRESSURING

The sketch illustrates how compressed air moves trapped oil away from barriers in the formation and pushes it to a well for recovery. The picture shows the top of an injection well, with air piping connected to it.

Old Mine Serves as Concert Hall



UNDERGROUND SYMPHONY

The orchestra and some of the audience are shown above silhouetted against the far wall of the rock-enclosed concert hall. At the upper left, Marilyn Thompson, featured soloist and her mother, Mrs. Grace Thompson, director of the orchestra, are shown with A. P. Feeney, an official of the mining company. At the left are members of the audience, some in fiesta costume, getting into cars for the trip into the mine.

NORTH of the border down New Mexico way is located the old San Pedro Mine, which has been producing gold by fits and starts for more than 100 years. Since it was first opened up, back in the days when New Mexico was a raw territory, much ore has been taken from these venerable workings, and the clatter of strange tongues has echoed up and down the corridors of the old mine. Recently—within the past two years—this property has been acquired by the Raskob interests, which bought it from the Santa Fe Gold & Copper Company. They have installed modern machinery, and made it into a profitable producer.

On the night of May 19, the ancient workings of the old San Pedro rang to a different music than the clang of steel against hard rock. Deep beneath the hills, in a mammoth room hollowed out by miners, the Albuquerque Civic Symphony Orchestra presented the final concert of its eighth successful season. Sixty musicians played under the direction of Grace Thompson, director of music at the University of New Mexico and leader of the orchestra since it was organized. More than 600 people heard the program; and the underground chamber could have accommodated many more. The featured soloist was the director's daughter, Marilyn, recently returned after four years of study of the harp under Carlos Salezo of Philadelphia.

Dressed in fiesta costume the guests gathered at the mine to be loaded into cars and sent down to within walking distance of the concert room. John J. Raskob of New York City was among them, together with his son R. P. Raskob, who is treasurer of the company; Miss Margaret Powers, a family friend; and Mrs. R. P. Raskob. Miners with their wives and children, native villagers from the surrounding country, and guests from Albuquerque and Santa Fe made up the audience.

The idea of holding a symphony concert in the San Pedro Mine originated with R. P. Raskob and Director Thompson of the orchestra, and they worked out the details of the affair. Special wiring was strung in order to light up the hall. Seats were provided for members of the orchestra, but the audience was obliged to stand. For the director's podium an ancient log was used, relic of some long gone day found in the room when the miners were cleaning out the loose rock. Around the podium were piled heaps of glittering ore that sparkled under the lights, and the somber shadows of the arching rock chamber formed a perfect backdrop for the gaily dressed musicians. The Albuquerque Civic Symphony Orchestra is a nonprofit organization with no paid musicians. It is supported by small admission charges to the concerts, which are held throughout the winter season. The concert in the mine was free.

The San Pedro Mine is located 36 miles northeast of Albuquerque near the Village of Golden. Since it has been acquired by the Raskob group, a modern 150-ton flotation mill has been built. The ore is delivered directly to the mill, and concentrates are trucked 20 miles to Stanley and thence shipped by rail to the American Smelting & Refining Company smelter at El Paso, Tex. From 75 to 100 men are employed at the mine, and many of them live in modern camp houses constructed by the company. Electricity for light and power is generated by a 360-hp. diesel-engine plant. Storage-battery locomotives do the underground hauling; and the rock drills used are supplied with compressed air by three 365-cfm. diesel-engine-driven machines.

Officers of the Raskob Company, all of whom live in Albuquerque, are: J. C. Barton, president; R. P. Raskob, treasurer; A. P. Feeney, vice-president and secretary; and Joe McCarthy, mine manager. The latter was formerly with the Newmont Mining Company of Grass Valley, Calif. In addition to their New Mexico property, the Raskobs also have extensive mining interests in Nevada and California.

SYNTHETIC RUBBER

SPURRED by the war in Europe, the development of substitutes for rubber has reached the stage where a plentiful supply of synthetic materials can be made available in the United States within a few months if the need for it arises. Various industrial concerns have been carrying on research in this field for a number of years, and such a substitute as neoprene is already well known. Until recently, however, these firms have been content to apply their products to special uses for which they possess advantages over natural rubber. There have been two reasons for this policy; the companies most prominent in the development are mostly manufacturers of rubber goods, or have close connections with them. As the rubber companies have huge investments in plantations in the Far East, there has been little disposition to push synthetics to the point of crippling the production of natural rubber. In the second place, the greater cost of synthetic rubber has obviously limited its use.

Now, however, there is a serious effort to make the nation self-sufficient and, to that end, the production of automobile tires from synthetic rubber has been begun. The B. F. Goodrich Company has announced that it is equipped to turn out from 500 to 1,000 tires a week from ameripol, a synthetic material on which its researchers have been working for fourteen years. The Standard Oil Company of New Jersey likewise reports the successful development of butyl, a general-purpose rubber substitute. Butyl has replaced buna, a German invention for which the oil company has manufacturing rights.

In addition to the products mentioned there are other American man-made rubbers such as thiokol, koroseal, chlorex, and vinyon. Some of them, including ameripol and butyl, are derived from petroleum: the others usually start with natural gas or coal. These raw materials are present in this country in great abundance, and it is estimated that production of synthetics could be readily expanded to more than 2,000 times the nation's present rubber consumption.

Rubber is currently selling at around twenty cents a pound, and at that level an automobile tire made of synthetic material will command a premium of some 30 per cent. However, if the price should rise to 73 cents a pound, as it did in 1925, or even to 48 cents, which it touched in 1926, the advantage would be heavily on the side of the man-made rubber. World production of crude rubber is running around 1,000,000 tons a year, of which the United States uses about 600,000 tons. Forty per cent comes from the Dutch East Indies and 50 per cent from British possessions in the same general region. Last year's output of synthetic rubber in the United States is given as 1,700 tons.

CHEESE TO THE FORE

FIGURES indicate that America is unmistakably becoming more cheese conscious. The per capita consumption of this food has grown in twenty years from 3½ to 5½ pounds. Cheese-making was confined to a few localities in 1920, but today it is carried on in virtually every state. With this expansion has come a great diversification in this dairy product. Swiss cheese no longer comes exclusively from Switzerland; in fact, the largest "Swiss-cheese" factory in the world is in Illinois. Similarly, Limburg cheese is no longer imported, having been supplanted by the flavorful and inexpensively produced domestic variety that, according to recent reports, is being deodorized.

America's cheese makers are even doing a good job of turning out a so-called Roquefort cheese from cow's milk, although the courts have ruled that only a cheese from sheep milk can rightfully be termed Roquefort. The making of this distinctive cheese has been a leading industry in southeastern France for two centuries. The curing is done in moist, drafty, caves in a limestone formation, and Americans have gone to considerable pains to duplicate these facilities. Natural caverns in sandstone cliffs near St. Paul, Minn., have been utilized during the past few years for curing 150,000 pounds of blue cheese, the Danish counterpart of Roquefort made from the milk of cows.

One Pennsylvania cheese maker discovered that conditions were almost ideal for Roquefort in the workings of an abandoned coal mine, and is using them for that purpose. For proper curing, the temperature should be maintained between 42° and 48°F., the air should be continually circulating, and the humidity should be near 100 per cent. Probably there are plenty of mines throughout the country that can meet these specifications; and, with the annual American cheese bill standing at $100,000,000 and growing steadily, perhaps cheese mines will come to be commonplaces before long.

OIL IS PLENTIFUL

IMPROVED geological methods of prospecting coupled with deep drilling have resulted during the past five years in discoveries of petroleum aggregating as great a quantity as was produced in the first 70 years of the industry in this country. The reserves added from 1935 through 1939 total more than 12,000,000,000 barrels, representing a gain over production of more than 6,000,000,000 barrels. This brings the total of proven reserves on January 1, 1940, to 18,500,000,000 barrels. In addition, there are vast areas known to be favorable to oil accumulation that are yet untested. Millions of tons of oil shales, as yet untouched, provide a further vast storage reservoir upon which future generations can draw when liquid deposits dwindle.

How the Roosevelt Tunnel was Driven

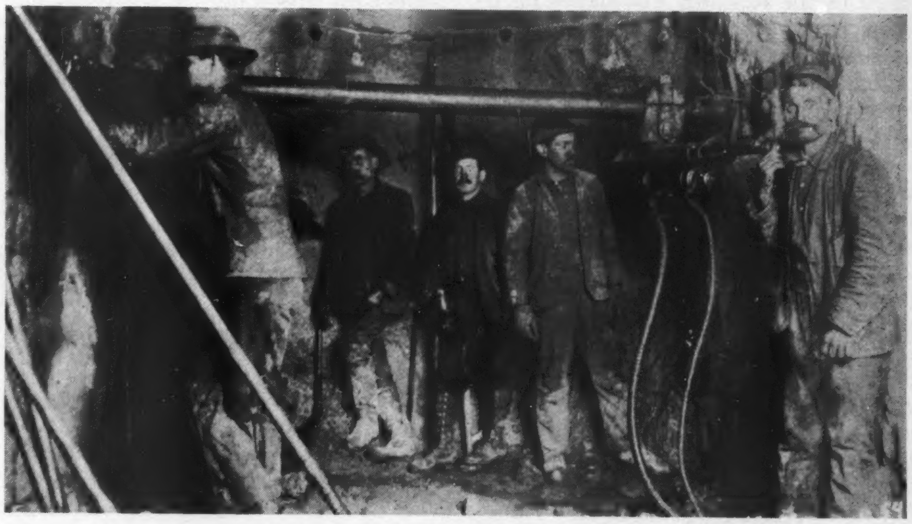
IN CONNECTION with the article on the Carlton Drainage Tunnel in our June issue, considerable mention was made of the Roosevelt Tunnel, a 24,000-foot bore that added many years to the lives of Cripple Creek gold mines. We have obtained some additional information regarding the methods used in driving the Roosevelt Tunnel, and this is presented here, together with the accompanying picture showing rock drills at work at a heading in 1908, the year work was started.

Drilling was done by means of three No. 5 Water-Leyner drifters, a forerunner of the Ingersoll-Rand DA-35 drifters now in service in the Carlton Tunnel. They were mounted on a horizontal bar, and a drilling crew consisted of three drill runners and two helpers. A "wedge" cut was used, the cut holes being 7 feet deep and the others 6 feet deep. The tunnel was 6 feet 4 inches high and 10 feet wide, with a side ditch approximately 4 feet deep and 6 feet wide at the top. This served to carry off water encountered during the excavating and was timbered over as work progressed, permitting tracks to be laid on it. From 24 to 26 holes made up a round, or one hole for each 3.3 to 3.6 square feet of heading. Compressed air, at 110 pounds pressure, was supplied by a Leyner compressor.

Gelatine dynamite of 40, 60, and 100 per cent strength was utilized for blasting. In the book *Modern Tunneling*, by David W. Brunton and John A. Davis, it is stated that "in the tough close-grained Pikes Peak granite 100 per cent dynamite was required before satisfactory results could be obtained. This is reported to have been the first 100 per cent dynamite put to use in tunnel work." Four muckers shoveled the broken rock into end-dump cars of 16 cubic feet capacity. These were hauled by horses or mules over 18-inch-gauge track made up of 20-pound rails.

The tunnel was ventilated by exhausting 4,800 cfm. of air from the headings through 16-inch pipe. Electricity was principally used for lighting, but the cost sheets also show expenditures for lamps and candles. The scale of wages was: Drillers, $5; helpers, $4; muckers, $3.50; power-plant engineer, $4; blacksmith, $5; helper, $3.50; dumpman, $3.50; inside drivers, $5; outside drivers, $4.

The tunnel was advanced from the portal and also both ways from the bottom of a shaft that was sunk to intercept the line. After it had passed the El Paso Mine shaft the muck was raised through it. The cost of the bore from February, 1908, to November, 1910, during which period it was driven 14,167 feet, was $385,511.49, or $27.21 per linear foot. The average monthly progress at the portal heading was 300 feet and at shaft headings 270 feet. The best progress was 435 feet made at one heading in January, 1909.



1908 DRILLING SCENE

A drilling crew at a heading in the Roosevelt Tunnel which has drained the deeper mines of the Cripple Creek, Colo., goldfield for more than twenty years. The drills are No. 5 Water-Leyners. Three drills were ordinarily used in a heading, and from 24 to 26 holes made up a round. The muck was hand shoveled into cars that were drawn by horses or mules to the portal or the nearest shaft.

Dean of Parachutists Retires

WITH parachute troops taking an important part in the war in Europe, it is of interest to note that the inventor of the modern parachute has just been retired from the U. S. Army. He is Master Sergeant Ralph W. Bottriel who, with more than 500 leaps to his credit, is called the dean of all parachute jumpers. He made his first leap 38 years ago during a carnival at Nashville, Mich., being carried aloft by a hot-air balloon. By the time he joined the Army, in 1909, he was already known as a daredevil 'chutist.

The first parachutes used to descend from airplanes opened as soon as the jumper left the ship, and there was imminent danger of the shroud becoming entangled in the tail section of the plane. To overcome this shortcoming, Sergeant Bottriel developed the 'chute that could be opened by the jumper after he had cleared the machine. This was the direct forerunner of the free-type, manually operated parachute that our army uses today. He demonstrated the first one at McCook Field, Dayton, Ohio, on May 19, 1919. For this leap, and the many others he made to prove that his invention was safe and practicable, he was awarded the Distinguished Flying Cross by the President.

Bottriel had many close escapes, but by continuing to jump, he was able to devise improvements and refinements in his parachute and to build up the confidence in it that led to its universal acceptance. His most spectacular leap was made in 1920, while he was attempting to set a new record for high-altitude descent. While he was preparing to jump from 20,000 feet, his 'chute opened prematurely, dragged him through the tail structure of the plane, and nearly tore off one of his arms. He almost bled to death before he reached the ground; but recovered from his injuries with no ill effects, and resumed his tests. He made his last leap in 1926, and since then has been acting as the leading parachute technician in the Army Air Corps.

ADJUSTING 'CHUTE

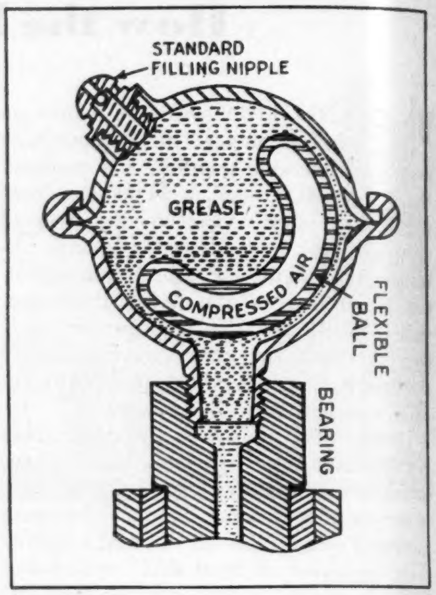
Sergeant Bottriell demonstrating to his last pupil the art of properly adjusting his parachute.

Experimental Foundry Nears Completion

THE building of an experimental foundry by the Research Foundation of Armour Institute of Technology, marks an important step in iron and steel production in that it is to house complete facilities for fundamental and applied research in that field. According to Harold Vagtborg, director of the foundation, the foundry is to be used primarily for the purpose of advancing the counter-gravity method of die-casting iron and other high-melting metals. These investigations have been made possible by the Wetherill Research Fund that has recently been established by Colonel Samuel Price Wetherill of the Wetherill Engineering Company of Philadelphia, Pa.

In the case of counter-gravity die-casting, or the pressure bottom-pour process, the familiar gravity-flow sand mold is replaced by a metal die which is above, not under, the crucible containing the molten metal. The latter is fed to the die through a refractory nozzle that extends well down into the crucible and with preheated air under pressure. Both the temperature of the molten metal and the pressure on it are maintained until the casting has reached a stage where shrinkage no longer takes place. Either single or multiple gray-iron castings are produced in this manner, and they are characterized by a structure that is dense, close grained, and exceptionally free from blowholes and oxidation. They have a tensile strength of approximately 40,000 pounds per square inch, as compared with 25,000 pounds for those made in the customary way. Furthermore, by eliminating sand and by reason of the fact that they can be held close to specified dimensions, castings made by the counter-gravity process have smooth surfaces and require little machining.

Pressure Lubricator



IT IS announced by the Simplex Manufacturing Company that its new pressure lubricator, shown in the accompanying line drawing, assures bearings a continuous, positive flow of grease while they or the shafts are in motion. The device consists essentially of a steel shell, and of a hollow ball inside the shell. The latter is equipped with a standard grease fitting carrying a pressure gun, and with a pipe-threaded outlet that screws into the standard lubrication passage to which the unit is permanently attached. The ball is made of neoprene—a rubber substitute that is flexible and resistant to the passage of gases.

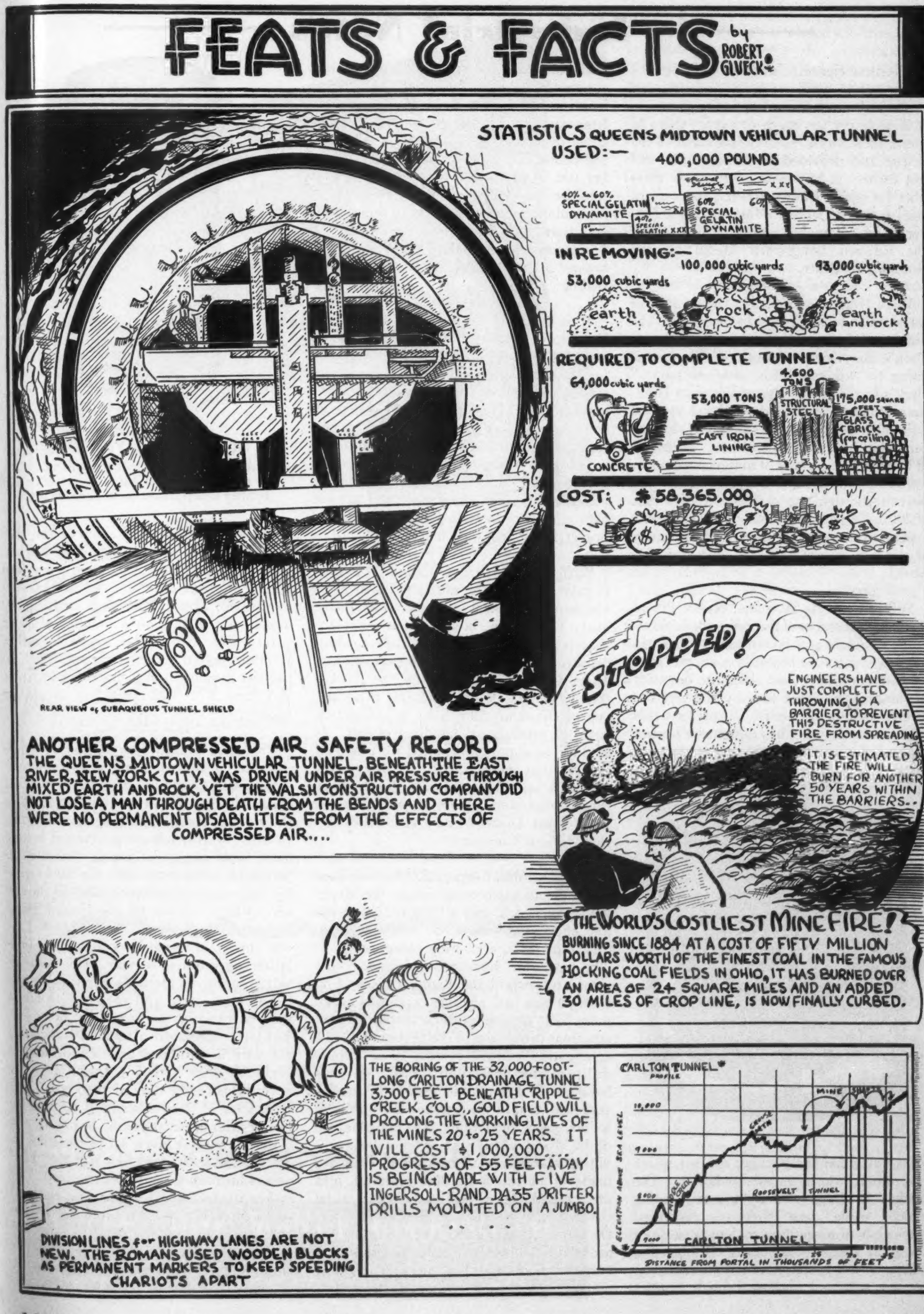
When grease has been forced into the shell by the gun until the former is under high pressure, the ball is compressed, together with the air inside of it. At that stage the lubricant flows out through the bearing with a flushing action, and continues to do so until the pressure in the shell drops to a point where it is equal to the resistance offered by the bearing to the passage of grease. After that the grease feeds to the bearing only when the latter is in motion and so long as the ball is under sufficient pressure to force it through the lubrication passage. When it ceases to do so, the shell is recharged. It has a capacity of ¼ fluid ounce, and this was found ample, it is said, to lubricate a standard automobile-chassis bearing for a run of 5,000 miles.

Compressed Air Stacks Towels in Bleachery

AT THE Danvers Bleachery in Peabody, Mass., visitors are amazed to see pillowcases and similar textiles pile themselves neatly, one on top of another, as they reach the end of a continuous belt conveyor. The answer is compressed air and electricity. The mechanism that makes this possible was supplied by the General Electric Company, and is called a photoelectric, automatic air doffer. It works in the following manner.

Upon emerging from a large ironer, the pillowcases pass on to the conveyor, the difference in speed between the two units serving to space the goods from 6 to 8 inches apart. As the first article comes from the ironer, its foremost edge interrupts a light beam and thus starts the operations. Once it is beyond the beam and the latter is no longer blanketed, the light strikes a photoelectric tube or electric eye and causes a solenoid valve to open for a period of about three seconds. In that interval, compressed air, at approximately 15 pounds pressure per square inch, flows into two perforated tubes that are set horizontally just beneath the discharge end of the belt conveyor. As the pillowcase reaches this point, the air from one of the pipes is directed upward against its front end, while the air from the second tube blows against the tail end, thus virtually floating it toward and laying it over the receiving rack. These operations are repeated over and over again as many times as there are pieces to be piled, and, as has probably been noted, are controlled entirely by the articles themselves.

PILED BY INVISIBLE MEANS
The discharge end of the belt conveyor, showing how the photoelectric air doffer works. Note the perforated pipes below the discharge end and how neatly the streams of compressed air lay the pillowcases over the receiving rack.



FEATS & FACTS
by ROBERT GLUECK
STATISTICS QUEENS MIDTOWN VEHICULAR TUNNEL
USED:— 400,000 POUNDS
40% to 60% SPECIAL GELATIN DYNAMITE
40% SPECIAL GELATIN XXX
60% SPECIAL GELATIN DYNAMITE
IN REMOVING:—
53,000 cubic yards earth
100,000 cubic yards rock
93,000 cubic yards earth and rock
REQUIRED TO COMPLETE TUNNEL:—
64,000 cubic yards CONCRETE
53,000 TONS CAST IRON LINING
4,600 TONS STRUCTURAL STEEL
175,000 SQUARE FEET GLASS BRICK (for ceiling)
COST: $58,365,000
REAR VIEW of SUBAQUEOUS TUNNEL SHIELD
ANOTHER COMPRESSED AIR SAFETY RECORD
THE QUEENS MIDTOWN VEHICULAR TUNNEL, BENEATH THE EAST RIVER, NEW YORK CITY, WAS DRIVEN UNDER AIR PRESSURE THROUGH MIXED EARTH AND ROCK, YET THE WALSH CONSTRUCTION COMPANY DID NOT LOSE A MAN THROUGH DEATH FROM THE BENDS AND THERE WERE NO PERMANENT DISABILITIES FROM THE EFFECTS OF COMPRESSED AIR....
STOPPED!
ENGINEERS HAVE JUST COMPLETED THROWING UP A BARRIER TO PREVENT THIS DESTRUCTIVE FIRE FROM SPREADING
IT IS ESTIMATED THE FIRE WILL BURN FOR ANOTHER 50 YEARS WITHIN THE BARRIERS..
THE WORLD'S COSTLIEST MINE FIRE!
BURNING SINCE 1884 AT A COST OF FIFTY MILLION DOLLARS WORTH OF THE FINEST COAL IN THE FAMOUS HOCKING COAL FIELDS IN OHIO, IT HAS BURNED OVER AN AREA OF 24 SQUARE MILES AND AN ADDED 30 MILES OF CROP LINE, IS NOW FINALLY CURBED.
THE BORING OF THE 32,000-FOOT-LONG CARLTON DRAINAGE TUNNEL 3,300 FEET BENEATH CRIPPLE CREEK, COLO., GOLD FIELD WILL PROLONG THE WORKING LIVES OF THE MINES 20 to 25 YEARS. IT WILL COST $1,000,000.... PROGRESS OF 55 FEET A DAY IS BEING MADE WITH FIVE INGERSOLL-RAND DA35 DRIFTER DRILLS MOUNTED ON A JUMBO.
CARLTON TUNNEL* PROFILE
10,000
9000
8000
7000
ELEVATION ABOVE SEA LEVEL
MINE SHAFTS
ROOSEVELT TUNNEL
CARLTON TUNNEL
5 10 15 20 25 30 35
DISTANCE FROM PORTAL IN THOUSANDS OF FEET
DIVISION LINES for HIGHWAY LANES ARE NOT NEW. THE ROMANS USED WOODEN BLOCKS AS PERMANENT MARKERS TO KEEP SPEEDING CHARIOTS APART

Industrial Notes

Heedless cigarette smokers who flip the butts out of windows have ruined if not destroyed many an awning in the past. As it is probably too much to expect them to mend their ways, research has come to the rescue and provided an awning that will not burn. It is woven of the new glass fiber for which Games Slayter, inventor of the process by which ordinary glass is converted into filaments, was recently awarded the Edward Longstreth Medal by the Franklin Institute.

With Hungarian riffles in the tailrace of its sand-and-gravel classifying plant, the builder of the huge Upper Narrows Dam at Park's Bar, Yuba County, California, is going to "kill two birds with one stone." Park's Bar is at the edge of the great Hammonton placer gold fields, and was covered with 80 and more feet of tailings during the early-day hydraulic operations. In excess of 600,000 cubic yards of material from this source is to be used on the project, and will be run through the classifier at the rate of 200 cubic yards per hour. The contractor expects to recover a considerable quantity of the yellow metal in the course of that work.

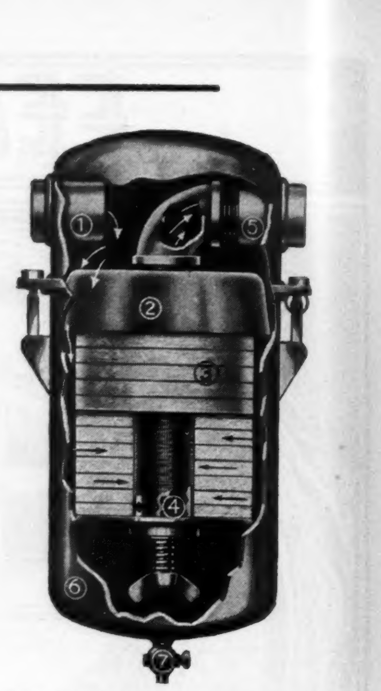
Spilled concrete is wasted concrete, and if you are a member of the Sidewalk Superintendents' Club, and cannot pass a job without stopping to see how it is done, you may have noticed that a considerable quantity of the material often falls by the way before it reaches the forms. To prevent this loss, a manufacturer has designed a bucket that will not leak for a long time to come, at

least not while the packing against which the outlet gate is seated holds out. The bucket is designed for bottom pouring which, while most effective, presented somewhat of a sealing problem because of the great weight of the mass. Rubber had all the desirable characteristics, but it soon became soft and useless through contact with the waste oil with which contractors commonly splash the inner surfaces at least once a day to prevent the concrete from sticking. The difficulty has been overcome by means of Neoprene—a synthetic compound that has all the qualities of rubber and, in addition, is resistant to oil. It is said that buckets of the new type have been in regular service for more than ten months and that the strips along the lips of the 2-part gate, *A-A*, and the bottom edge of the hopper are still doing an effective job of sealing.

It is reported by the U. S. Consul in Frankfort, Germany, that a mineral fiber introduced there in 1939 and used mainly for the making of filter cloth is now also serving as a substitute for iron in reinforcing concrete. It is a polyvinyl-chloride product—an acetylene derivative with a percentage of hydrochloric acid. In addition to being as strong as iron and fireproof, it is said to be light in weight, resistant to water, acids, alkalies, and rust, and to have high elasticity as well as great insulating properties against heat and cold.

With the approach of summer, it is time to take a look at the salt-tablet dispensers for men in industry exposed to excessive heat. To keep the body fit, it is necessary that it be given salt periodically to compensate for that lost through perspiration. There is a new dispenser on the market that is said to be proof against moisture, one of the main difficulties in connection with the storing and handling of salt. It is made of aluminum, plated by a special process that meets the U. S. Navy anticorrosive specifications, and holds more than a thousand 10- or 15-grain tablets. It is called Dispens-Eze and is made by the Milburn Company.

Staynew Filter Corporation has produced a new Protectomotor air filter—the Model AAPHS—which, like all the others in the line, effectually removes oil, moisture, dust, dirt, pipe scale, etc., from compressed air. The new unit, however, is primarily designed to prevent the slightest trace of oil from pa sing into air lines, and was originally built to solve a difficult problem of instrument protection in connection with the combustion control system of a public-utility electric power unit. Since then it has been put to many other uses and is now a standard item in the Staynew line of filters for air, gases, and liquids. The main feature of the Model AAPHS is a series of disks providing a large area of absorption. They are made of Feltex, a felt-like material, and are carried on a perforated-metal tube covered with a screen of fine bronze wire. On top of the disks and directly below the air inlet is an inverted deflector cup which removes most of the oil and other foreign matter from the air by centrifugal action,



STRUCTURAL FEATURES

1, Air intake; 2, deflector cup; 3, filter disks; 4, perforated metal tube; 5, air outlet; 6, filter shell; 7, drain cock; 8, swing bolts.

throwing it against the sides of the shell whence it flows or drops down into the bottom. The lower part of the shell is provided with a drainage cock and can be easily removed for inspection and cleaning by loosening the nuts on a number of swing bolts. The unit is also available with a standard bolted head and in sizes and capacities ranging from ¼-inch to 2-inch pipe and from 5 to 100 cubic feet of air per minute.

Through the introduction of a small-diameter insulated building wire—branch circuit wire, conduits that have reached their capacity can carry as much as twice the wattage simply by changing the wiring. In other words, homes, apartment houses, office buildings, and the like, that need to be modernized electrically can do so without incurring expensive repairs. In the new wire, which is made by the United States Rubber Company and is named U. S. Laytex, the space formerly occupied by insulation is given over to wire. This is the result of improved methods of purifying rubber in latex form and of the dip or pass process by which the insulation is applied. The latter consists in alternately immersing the wire in the latex and withdrawing it vertically into a drying tower until the covering is of the desired thickness. Vulcanization of the rubber may be done before or after application. U. S. Laytex wire is said to meet a given set of electrical requirements with less than half the thickness of insulation heretofore specified. This makes it possible to double the electrical capacity of existing conduits and to provide without much difficulty additional current that may be desired for better illumination, for air conditioning, and for the operation of modern electric appliances.

By means of what is named an Area Determinator, a product of the American Instrument Company, it is possible to calculate in square centimeters the surface of any flat object with a maximum diameter of less than 10 inches regardless of how irregular its outline may be. It is claimed that an operator can, without previous experience, position the work and take a reading in about one minute and that the reading, when multiplied by five, is within 3 per cent of the true area.

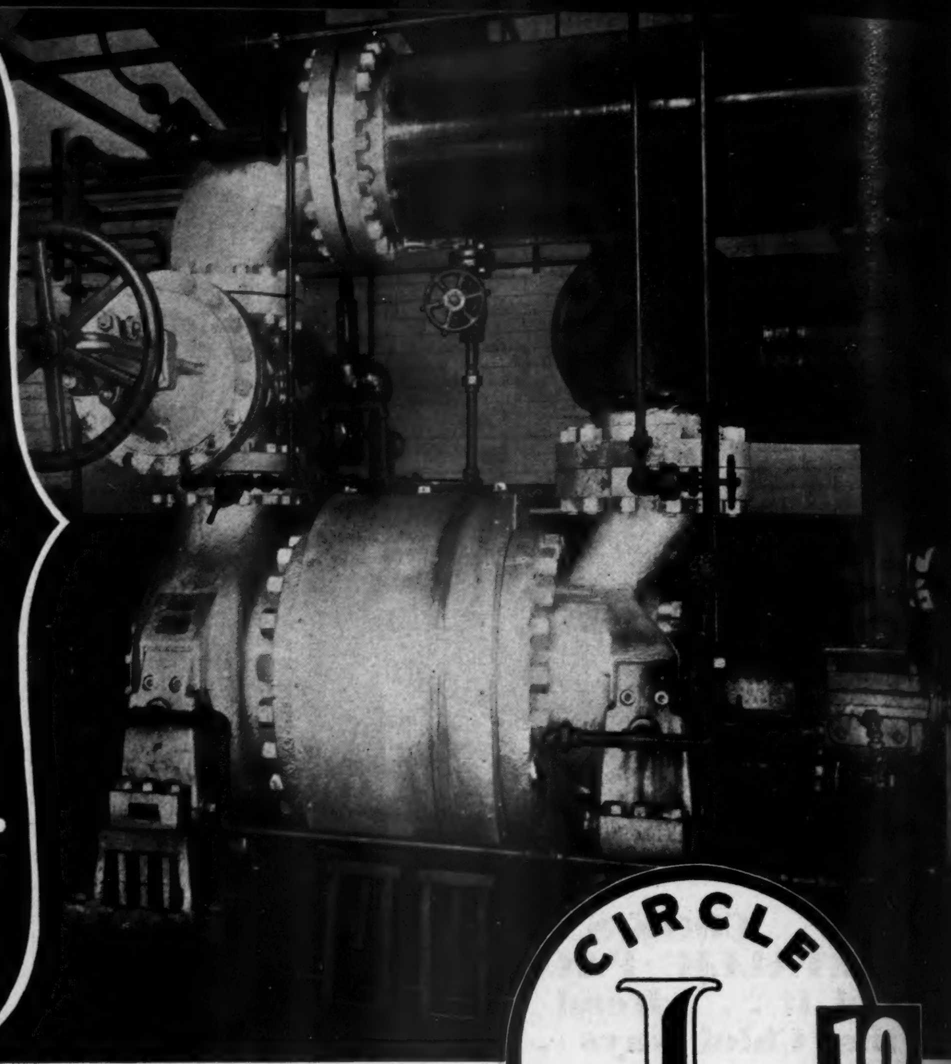
A new chemical heat-transfer material for processing operations has been placed on the market under the designation of HTS. It is in the form of a solid salt which becomes fluid at 288°F. and can be pumped through a line at atmospheric pressure, transferring heat of 900°F. the while. As compared with heated air, the salt solution is said to be much more effective and to require far less power to circulate it through the pipes.

It sounds unbelievable, but there is a copper mine in the western Cordillera of Chile which deposits its tailings in a natural settling basin 36 miles away from the mill. The basin lies 5,000 feet below the plant and is reached by a series of flumes about 3 feet square. The former is 3 miles long, 1½ miles wide, and has a capacity of 270,000,000 tons. At the present rate of discharge, it is ample to meet the company's needs for the next 40 years. The tailings are classified at the basin—the sand being used to build a dam 110 feet high at its mouth while the slimes are wasted and flow down to the bottom of the expansive valley.

Oilite, which has previously been mentioned in these pages, is now available in cored and solid bars, plates, and strip stock. The material has been on the market for some time in the form of bushings, rings, washers, etc., and is made of powdered bronze impregnated with oil—the quantity absorbed being equivalent to one-third its volume. The bars range in outside diameter from ½ inch to 5⅞ inches and are up to 6½ inches long; the plates are 5x6 and 5x8 inches in size and vary from 3/16 to 1 inch in thickness; and the strip stock is 4 and 8 inches wide and 18 and 24 inches long, respectively.

What next! No less than a chemist has invented a method of shampooing hair with air under pressure. The stream is directed against the scalp by parting the hair at ½-inch intervals and following the part with the gadget by which the air is applied. After the head is air-blown, says our informant, a dry medicated powder is combed through the hair and flushed out by the same stream. The result—a fluffy clean head of hair, so it is claimed. The dry shampoo takes half an hour and is in use in Pacific Coast beauty shops. A leading New York department store has introduced it to the East.

800 lbs. pressure at 660° F...



CIRCLE L 10

. . . that called for LEBANON Alloy Steel Castings in this Cameron Pump for Richfield's new refinery

One of the two AHT 6-stage Cameron centrifugal pumps which charge the two cracking units in the new Richfield Oil Corp. refinery at Watson, Calif. Suction heads and discharge heads are Lebanon castings, made from Circle L 10, a special alloy for the oil industry.

AS TEMPERATURES and pressures in oil refineries go up, materials must keep pace. Good-enough-for-yesterday has no place in a modern cracking plant.

When Ingersoll-Rand built the two giant Cameron pumps to charge the cracking heaters in the new Richfield refinery at Watson, Calif., they laid down rigid materials specifications for each part.

With a background of long service to the oil industry, an exceptionally modern foundry practice and complete metallurgical laboratory facilities, Lebanon Steel Foundry was called upon to supply the suction heads and discharge heads for these 1400 GPM giants.

Circle L 10, Lebanon's special alloy for oil refinery service was used. This Chromium Alloy with Molybdenum has high tensile properties combined with high yield point and low creep. It satisfactorily resists corrosive action of hydrogen sulphide and other sulphur gases, wet or dry at temperatures up to 1100° F.

These characteristics have earned it a place as the standard cast steel for modern oil refinery service.

LEBANON STEEL FOUNDRY ▪ LEBANON, PA.

Original American Licensee George Fischer (Swiss Chamotte) Method

Lebanon STAINLESS AND SPECIAL ALLOY Steel Castings